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II:31

DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

THE PRODUCTION OF COAL IN 1913

By EDWARD W. PARKER

Mineral Resources of the United States, Calendar Year 1913—Part II
(Pages 709–928)

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1914

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CONTENTS.

	Page.
Introduction	709
General statement	709
Acknowledgments	710
Unit of measurement	710
Summary of statistics for 1913	711
Production	718
Statistics of production for 1912 and 1913	718
Production of coal in the United States from the earliest time to the close of 1913	727
Coal fields of the United States	730
Rank of coal-producing States	736
Production by classes of mines	738
Kinds of coal produced in the United States	747
Labor statistics	750
Strikes and suspensions	757
Coal mined by machines	756
Mining methods	765
Coal-washing operations	768
Values per ton	769
Shipments by railroads	771
Imports and exports	779
Tariff	780
World's production of coal	781
Coal-trade review	784
New York City	784
Philadelphia, Pa	790
Boston, Mass	793
Baltimore, Md	795
Norfolk and Newport News, Va	798
Pittsburgh, Pa	800
Buffalo, N. Y	802
Cincinnati, Ohio	803
Cleveland, Ohio	804
Milwaukee, Wis	805
St. Louis, Mo	807
San Francisco, Cal	808
Production of coal by States	809
Alabama	809
Alaska	813
Arkansas	815
California	818
Colorado	820
Georgia	824
Idaho	826
Illinois	826
Indiana	833
Iowa	837
Kansas	841
Kentucky	844
Maryland	850
Michigan	853
Missouri	856
Montana	861

Digitized by Google

Production of coal by States—Continued.
Individual states—Continued. Page.
New Mexico ... 864
North Dakota ... 866
Ohio ... 870
Oklahoma ... 875
Oregon ... 878
Pennsylvania ... 880
Anthracite ... 883
Bituminous ... 896
Tennessee ... 901
Texas ... 904
Utah ... 907
Virginia ... 910
Washington ... 914
West Virginia ... 917
Wyoming ... 922
Survey publications ... 926

ILLUSTRATIONS.

FIGURE 17. Production of coal in the United States in 1913, by States ... 721
18. Yearly production of anthracite and bituminous coal from 1856 to 1913, in short tons ... 722
19. Average yearly production of coal in the United States for 1814–1845 and for each decade since 1845, in short tons ... 728
20. World's production of coal ... 782

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COAL.

By EDWARD W. PARKER.

INTRODUCTION.

GENERAL STATEMENT.

The coal-mining industry of the United States in 1913 was without spectacular features, the increase in production as compared with 1912 being about normal and indicative of general industrial activity throughout the country. Out of 30 States which contributed to the production in 1913 there were only 6 among the important States in which the output was less than in 1912, and, as the increases varied in percentage from 0.33 in Wyoming to 19 in Kentucky, with an average of 6.66, it can be seen that the business activity was well distributed over the country.

There were a few labor disturbances in 1913, but they were local in extent and effect. The most pronounced labor disaffection was in Colorado, where a general strike was called about the middle of September, and coal production in that State during the last quarter of the year was but little more than 50 per cent of normal. The wage contracts in the "organized" States usually date from April 1 of the "even" years, and as 1913 was an "odd" year, there was no general suspension of work pending the adjustment of the scale, and the loss of time by strikes was negligible. There was some complaint, particularly in the Eastern States, of shortage of labor and inability on the part of the operators to keep their mines working at full capacity. This was probably the reason for less than the usual complaint of the inadequate or insufficient transportation service. Coal mining, like all other industries in the Ohio Valley States, was seriously interfered with by the floods in that region during the spring of 1913, and probably from 5,000,000 to 10,000,000 tons of coal would have been added to the year's output but for that great disaster. The demand by the blast furnaces, steel works, and other manufacturing industries, particularly during the first nine months of the year, was good, and the production of coal for those purposes showed a normal increase. The continued decrease in the use of fuel oil in the Mid-Continent oil field and the strike in the Colorado coal mines resulted in an increased output of coal in the Central and Southwestern States.

With the exception of Illinois, in the first six States, which together produce over 80 per cent of the total output, values ranged higher than in 1912, or in any normal recently preceding year. An unfortunate record was an increase in the number of fatalities among the mine workers, the reports to the Bureau of Mines showing a total of 2,785

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fatal accidents in the coal mines in 1913 against 2,360 in 1912. There were three disastrous explosions of coal dust in the bituminous mines in 1913, the worst of which at Dawson, N. Mex., in October, caused the death of 261 men. The other two were at the Cincinnati mine in Pennsylvania and at the Vulcan mine in Colorado, the former resulting in the death of 96 men and the latter, 37. The returns for 1913 show a gratifying decrease in the quantity of coal shot off the solid, though there is still much room for improvement in that respect. The more frequently and emphatically the practice is condemned by writers and speakers, and the more it is prohibited by law and by company rules, the better it will be for the industry and for the safety of the miners. Legislation which provides for the payment of miners' wages on the mine-run basis, however, does not tend to reduce the practice.

The report for 1910 contains sectional maps of the coal fields of the United States, with brief descriptions prepared by geologists of the Survey. Copies of that report are still available and can be secured free of charge upon application to the Director of the United States Geological Survey.

ACKNOWLEDGMENTS.

The statistics of coal production, as of other branches of the mining industry, are compiled from direct returns by the operators. They could not be secured in the completeness in which they are presented without the hearty good will and cooperation of the corporations, firms, and individuals engaged in the industry, and the author desires to reiterate and emphasize his appreciation of the assistance received from those sources. Acknowledgments are due also to the State Geological Surveys of Alabama, Georgia, Illinois, Iowa, Kansas, Maryland, New Mexico, Oklahoma, Oregon, Pennsylvania, Virginia, and Washington for efficient cooperation in the collection of coal-mining statistics in those States; to the mine inspectors of Alabama, Ohio, and West Virginia; and to the secretaries of boards of trade or other local authorities for contributions on the coal trade of some of the principal cities. Recognition of these contributions is also given in connection with their contributions under the caption, "Coal-trade review." Not the least of the writer's acknowledgments are due to his faithful and efficient clerical and stenographic assistants in the United States Geological Survey. The entire statistical compilations in the following pages, with the exception of Pennsylvania anthracite, have been prepared by Miss Lida Mann. The anthracite tables were prepared by Miss E. H. Burroughs.

UNIT OF MEASUREMENT.

The standard unit of measurement adopted for this report is the short ton of 2,000 pounds, although it is necessary in a few instances to use the long ton. All of the anthracite product is mined and sold on the basis of the long ton of 2,240 pounds. Hence, when the production of Pennsylvania anthracite is considered, the long ton is used. The long ton is also used in the statistics of imports and exports. In all other cases where the production is reported in long tons the figures have been reduced to short tons, and unless otherwise expressly stated, the short ton is meant where any statement of quantity is made in the text.

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SUMMARY OF STATISTICS IN 1913.

Total production in 1913, 570,048,125 short tons; spot value, $760,488,785.

Pennsylvania anthracite.—Total production in 1913, 81,718,680 long tons (equivalent to 91,524,922 short tons); spot value, $195,181,127.

Bituminous coal and lignite.—Total production in 1913, 478,523,203 short tons; spot value, $565,307,658.

Production.—In a preliminary review of the coal-mining industry in 1913, given to the press on December 29 of that year, the production was estimated at between 565,000,000 and 575,000,000 short tons, which indicated an increase of 30,000,000 to 40,000,000 tons over the previous record-breaking production of 1912. With less than one-half of 1 per cent of the total tonnage unreported on July 1, 1914 (the delinquent production being estimated on the basis of previous years or from reliable sources of information), the output in 1913 is found to have amounted to 570,048,125 short tons, or almost exactly midway between the extremes estimated six months before. The increase over 1912, when the production amounted to 534,466,580 short tons, was 35,581,545 short tons, or 6.7 per cent. The year 1912 had also established a new record for normal years in the total and unit values for the product, the average value per ton having exceeded that of any year for which statistics are available, with the single exception of 1903 when, because of the fuel famine caused by the great strike in the anthracite region of Pennsylvania and in the "organized" bituminous States, the prices of all kinds of coal were advanced above any figures reached in recent history. The higher values in 1912 were not only maintained but generally improved upon in 1913, the general average value per ton showing an advance of 3 cents over 1912, and reaching within 8 cents of the record high average of 1903. A notable exception to the higher prices obtained in 1913 among the more important producing States was in Illinois, where, because of peculiar local conditions, the average value showed a decline. The total value of the combined production of anthracite and bituminous coal in 1913 was $760,488,785 which, compared with 1912, when it amounted to $695,606,071, showed a gain of $64,882,714, or 9.3 per cent.

The production of anthracite in Pennsylvania increased from 75,322,855 long tons (84,361,598 short tons), valued at $177,622,626, in 1912 to 81,718,680 long tons (91,524,922 short tons), valued at $195,181,127, in 1913. The increase in quantity was 6,395,825 long tons (7,163,324 short tons), or 8.5 per cent, and the gain in value was $17,558,501, or 9.9 per cent.

The total production of bituminous coal and lignite increased from 450,104,982 short tons in 1912 to 478,523,203 tons in 1913, the increase in quantity amounting to 28,418,221 tons, or 6.3 per cent, with an increase in value of $47,324,213, or 9.14 per cent, from $517,983,445 in 1912 to $565,307,658 in 1913.

The increase in the production of anthracite was somewhat exceptional and due to the fact that the output in 1912 was reduced nearly 5,500,000 long tons by a "suspension" in April and May, practically the entire region being idle pending an agreement on the renewal of the terms of employment. Compared with 1911, when

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there was no general strike or suspension in the region, the production in 1913 showed an increase of less than 1,000,000 long tons. The advance in price and relatively larger gain in value were the result of the advance in wages granted in the new agreement.

Increases in bituminous production were generally distributed over the country, there being only six States where the production in 1913 was less than in 1912, and in one of those States, Colorado, the dercease was due entirely to labor troubles. During the first nine months of the year the activity in the iron and steel trades which had developed in 1912 was well maintained and created activity in the coking-coal districts. This fell off somewhat sharply during the last quarter of the year, but the demands from other lines of manufacture and from the railroads were well sustained. In the Central and Southwestern States the production of coal was stimulated through the continued decrease in the production of natural gas in the northern part of the mid-continent field and the withdrawal of large quantities of fuel oil from the markets. There was some complaint of labor shortage, but in that respect also there was an improvement, compared with 1912, many of the mine workers who had returned to Europe to enlist in the Balkan war having resumed their places in the coal mines throughout the country, and particularly in the Western States. Such deficiency as existed was not altogether an injury, however, for it enabled operators to maintain prices and prevented an output in excess of market requirements. It was also probably responsible for fewer complaints of insufficient transportation facilities.

In the production of both anthracite and bituminous coal the gain in output was accompanied by a larger proportionate gain in value. The largest increase in the production of bituminous coal was in Pennsylvania where 11,915,729 tons were added to the output, as compared with 1912. West Virginia showed the second largest gain, 4,522,295 tons. But the most significant increase was in Kentucky, which showed the third largest gain—3,126,079 tons, and the largest percentage of increase among the important coal-producing States. Indiana came fourth with an increase of 1,879,953 short tons; Illinois fifth, with 1,733,518 tons; Ohio sixth, with 1,671,800 tons; and Alabama seventh, with 1,577,922 tons. No other State increased its production as much as a million tons and only one State, Virginia, approached within 60 per cent of that figure. The only important State to show a decrease was Colorado, whose production fell off nearly 1,750,000 tons on account of labor troubles. One State, Wyoming, showed an increase in production and a decrease in value, and one State, Maryland, had a decrease in quantity of output and an increase in value.

Production per capita.—The development of the coal-mining industry in the United States, considered with the increase in the population, presents some interesting comparisons. The use of mineral fuel became an important factor in the manufacture of iron, about the middle of the last century. In 1855 anthracite exceeded charcoal as a blast-furnace fuel, and 20 years later was superseded by coke. In 1850 the production of coal amounted to 7,018,181 short tons, or at the rate of 0.3 ton for each of the 23,191,876 inhabitants. In 1860 the population had increased to 31,443,321 persons and the production of coal to 14,610,042 tons, or an average of 0. 46

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ton per person. In 1880 when the population had increased to 50,189,209, the production of coal had increased to 71,481,570 tons, or an average of 1.42 tons per capita. In the closing year of the nineteenth century, according to the Twelfth Census, the total number of inhabitants in the United States was 76,303,387, an increase of a little over 50 per cent, as compared with 1880, while the production of coal was nearly four times that of 20 years before and amounted to 269,684,027 short tons, or an average of 3.53 tons for each inhabitant. At the taking of the Thirteenth Census, in 1910, the population of the United States numbered 91,972,266 persons, and as the production of coal in that year amounted to 501,596,378 short tons, the per capita production was 5.45 tons. From this it appears that in the 50 years from 1850 to 1900 the per capita production of coal in the United States has increased from less than one-third of a ton to nearly 5½ tons. The Bureau of the Census estimates that the population of the continental United States in 1913 was 97,163,330 persons, and the production for each inhabitant was 5.87 tons. In addition to the production of coal in recent years the output of petroleum and natural gas, both mineral fuels, should also be considered. Large quantities of petroleum, crude or residual, are used for fuel purposes, and by far the larger part of the natural gas is also used as a manufacturing fuel. The consumption of petroleum fuel in 1913 was probably equivalent to between 23,000,000 and 24,000,000 short tons of coal and the quantity of coal displaced by natural gas was probably more than half as much. If these liquid and gaseous fuels were convertible into their equivalents in coal and that factor were added to the total coal production, the per capita consumption of coal in 1913 would easily exceed 6 tons, or, in other words, the consumption of mineral fuel per capita at the present time is 20 times what it was in 1850.

Men employed.—The coal mines of the United States gave employment in 1913 to an army of nearly three-quarters of a million men. The anthracite mines of Pennsylvania gave employment to 175,745 men and the bituminous mines to 571,899 men, the total being 747,644 men. As 1913 was not a year in which the wage agreements terminated, there was no general suspension among the organized miners although two desperate struggles to force the recognition of the union were carried on, one in the Kanawha field in West Virginia had been inaugurated in 1912 and kept on well into 1913; the other in Colorado was begun in September, 1913, and continued into 1914. The number of men affected by these struggles was less than 5 per cent of the total number of mine workers, and the idleness did not materially influence the average working time for the bituminous-mine workers as a whole. The average number of days made by the employees in the bituminous mines was, with three exceptions, 1899, 1900, and 1907, the largest made in any year in the history of the industry. The average time made in the bituminous mines in 1913 was 232 days against 234 days in each of the three years mentioned. In 1912 the bituminous mines were operated an average of 223 days. The average time made in the anthracite mines in 1913 was the best on record, 257 days. In 1901 the anthracite operators adopted the policy of allowing discounts on coal sold during the spring and summer months, the idea being to encourage consumers to lay in their winter supplies at a time when transporta-

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tion is not hampered by unfavorable weather and when otherwise a large number of men would be idle. The effect of this has been to give much steadier employment through the year and to prevent to a large extent congestion of orders and traffic in the fall and winter months. The fluctuations in the number of days worked from year to year in the anthracite region since the discount policy was put into effect have been due principally to suspensions pending adjustments of wage agreements. Anthracite, being almost entirely a domestic fuel, is not affected to the same extent as bituminous coal by trade conditions. On account of the larger number of days made in the anthracite mines in 1913, the average production per man increased to 520 tons, compared with 485 tons in 1912, but the decreasing daily production which has been noted in previous reports did not show any improvement in 1913, the average for 1913 being a small fraction of a ton less than in 1912. The average production per man in the bituminous mines increased from 820 tons in 1912 to 837 tons in 1913, both being record-making averages. As in the anthracite mines, however, the bituminous workers showed a slight falling off in the average daily production per man, the figures being 3.68 tons for 1912 and 3.61 tons for 1913.

Mining machines.—It is doubtful if the great tonnage records made by the bituminous mines of the United States in the last two decades could have been attained with the supply of labor available but for the use of machines in the mining of the product. To the mechanical production of bituminous coal may be attributed the marked increase in the average tonnage mined by each employee, as shown in another part of this report. The percentage of machine-mined bituminous coal to the total production has increased regularly since 1896, the first year for which the statistics of this feature of the coal-mining industry have been collected. In 1913 the quantity of bituminous coal mined by machines was 242,476,559 short tons, or 50.7 per cent of the total, against 210,538,822 tons, or 46.8 per cent of the total in 1912. In 1896 the production of coal by machines was 16,424,932 tons, or not quite 12 per cent of the total. The increase of this item in 1913 over 1912 was 31,937,737 short tons, or 3,519,516 tons more than the total increase in the production of bituminous coal. The prevailing type of machines are punchers, chain-breast, long-wall, short-wall, and continuous-cutter machines for relatively flat-lying beds, and radially-actuated punching machines mounted on rigidly fixed posts for beds of too steep inclination for the other types of machines. The machines of the puncher type, as the name implies, cut the coal by a chopping action; in the others the action is that of sawing. A new type of machine introduced in 1913 has the cutting bits arranged spirally upon a tapered arm which revolves and reciprocates at the same time, combining a boring and sawing action. The total number of machines reported in use in 1913 was 16,381 against 15,298 in 1912. The average production for each machine increased from 13,763 tons to 14,802 tons, the latter being the highest record ever made.

The increase in the production of machine-mined coal in 1913 reduced not only the percentage but the quantity of coal "shot off the solid," that item showing a decrease from 76,241,575 short tons, or 17 per cent, in 1912 to 75,155,707 tons, or 15.7 per cent, in 1913. These figures are gratifying and indicate that the warfare waged by

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speakers and writers against the pernicious practice of "making the powder do the work" has not been been without result. The practice can not be too vigorously condemned and the campaign against it should be rigorously prosecuted until it has been entirely abolished. It is dangerous to the mines and miners, seriously vitiates the quality of the product, and is contrary to every tenet of conservation. The worst offenders in this regard are the States of the western and southwestern regions of the interior province, where, above all, because of the low value of the slack coal produced, careful mining should be the rule. Yet fully 80 per cent of the coal produced in the western and southwestern regions is powder mined.

Labor troubles.—As the wage scale agreements in the "organized" bituminous coal-mining States are continued from April 1 to March 31, of the "even" years, there was no general strike or suspension in the States operating under contracts with the mine-workers' union. In the the anthracite region of Pennsylvania after an idleness of about seven weeks, from April 1 and May 15, 1912, a third renewal of the Anthracite Strike Commission's awards was effected, with some modifications and with an advance of 10 per cent in wages, the extension in this instance being for a period of four years, or until March 31, 1916. The year 1913 was not, however, without serious conflicts between employers and employees. The state of warfare in the Paint and Cabin creeks districts of West Virginia, which made a blot on the record of 1912, was carried over into 1913 and when peace was finally effected it proved to be simply of a temporary character, but lasted through the remainder of the year. The conflict was renewed in the early part of 1914, and at the time of writing this report is still undetermined. The most serious difficulty of the year was in Colorado, where in an attempt to force recognition of the union upon the operators a strike was called to take effect on September 23, and from that date until the close of the year a state of affairs bordering on civil war existed. The fair name of the State was besmirched by acts of bloodshed, arson, and other excesses which the military arm of the State was unable to stop, and it was finally necessary to call in the aid of the United States troops to reestablish law and order. In the entire State of Colorado 7,324 men out of a total of 11,990 were idle for an average of 75 days, and the production for the year was reduced about 16 per cent. The trouble in West Virginia was more localized and affected only 8,800 men out of a total of 74,786, and the deficiency in the production of Kanawha County was made up by increased tonnage from other districts in the State.

Local labor disturbances will continue as long as coal continues to be mined, and 1913 was no exception to the rule, although there were ten States in which no strikes or suspensions were reported during the year. The most conspicuous instance was Virginia, which produced a total of nearly 9,000,000 tons of coal with not a case of strike, suspension, or lockout reported. Wyoming also with a production of nearly 7,500,000 tons, had a clean labor score. The other eight States were relatively unimportant producers, namely, Alaska, California, Georgia, Idaho, Nevada, North Dakota, Oregon, and Texas. Local troubles in the anthracite fields were most numerous, but not prolonged, 64,086 men, more than one-third the total number, being on strike for an average of 8 days each. Among the bituminous States

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Pennsylvania had the largest number of idle men, and Illinois had the largest number of idle days.

Accidents.—The record of fatalities in the coal mines of the United States compiled by the Bureau of Mines for 1913 showed an unfortunate increase over the preceding year, the number of men killed increasing from 2,360 in 1912 to 2,785 in 1913. Of the total number of fatalities in 1913, 618 were in the anthracite mines of Pennsylvania, and 2,167 in the bituminous and lignite mines. As is usually the case, the most prolific cause of death was falling roofs and coal which claimed 1,264 victims, or 45.4 per cent of the total number of deaths. In 1912 the deaths due to falls of roof and coal were 1,151, or 48.8 per cent of the total. The increase in the number of fatalities in 1913 over the preceding year was due principally to three explosions of dust in the bituminous mines, the worst of which was the disastrous explosion at Dawson, N. Mex., in October, the immediate result being the death of 261 mine employees. Next to this in the number of men killed was the explosion in the Cincinnati mine in Washington County, Pa., which occurred in April and resulted in the death of 96 men. On December 16 an explosion at the Vulcan mine, near Newcastle, Colo., killed 37 employees. The total number of men who lost their lives by dust explosions in 1913 was 423, against 137 in 1912. There was a decrease in the number of men killed by explosions of gas from 164 in 1912 to 91 in 1913. Of the 91 victims in 1913, 50 were in the anthracite mines of Pennsylvania, and 41 were in the bituminous mines of Alabama (3), Illinois (8), Indiana (7), Kansas (1), Ohio (15), Oklahoma (2), and Washington (5). Mine cars and locomotives underground killed 424 men in 1913 against 362 in 1912, and 78 men were killed from that cause on the surface in 1913 against 68 in 1912. Premature blasts and other accidents incident to the use of explosives killed 138 men in 1913 and 133 in 1912. The total number of fatal accidents underground increased from 2,119 in 1912 to 2,562 in 1913. Shaft accidents increased from 54 to 62, and the total number of fatalities on the surface decreased from 187 to 161. The death rate per thousand employees in the anthracite region was 3.52 against 3.35 in 1912. In the bituminous regions the death rate per thousand was 3.79 in 1913 against 3.24 in 1912, and the death rate for the entire country in 1913 was 3.73 against 3.28 in 1912. The quantity of anthracite mined for each life lost in 1913 was 132,231 long tons (148,098 short tons) against 128,978 long tons (144,455 short tons) in 1912, and the quantity of bituminous coal mined for each fatality in 1913 was 220,823 tons against 253,437 tons in 1912. The total of anthracite and bituminous coal mined for each life lost in 1913 was 204,685 tons against 226,469 tons in 1912.

Washed coal.—The production of anthracite in Pennsylvania includes an appreciable quantity of usable fuel recovered from the old culm banks by washeries, and the unsightly monuments to the wasteful methods of early times are disappearing from the landscape in the anthracite region. The quantity of coal recovered in the 24 years since the first washery was constructed (in 1890) has amounted to about 49,300,000 long tons, considerably more than the annual production of anthracite at the beginning of the period. In 1913 the washery product amounted to 2,860,021 long tons. In addition to the coal recovered from the culm banks, 133,986 long tons in 1913, and 85,722 long tons in 1912, were recovered from the bottom of

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Susquehanna River by dredges. The quantity of coal recovered from the old culm banks by washeries in 1913 was 1,305,267 tons less than in 1912, and decreasing proportions of this product may be anticipated in the future, as the culm banks disappear.

In the bituminous regions the principal use of washeries is to improve the quality of the slack coal used in the manufacture of coke by reducing the ash and sulphur, although considerable quantities, particularly in Illinois, are washed in the preparation of sized coal for household use. The quantity of bituminous coal washed at the mines in 1913 was 25,051,801 short tons. The washeries yielded 22,069,691 tons of cleaned coal and 2,982,110 tons of refuse.

Consumption.—More than 95 per cent of the total production of anthracite and bituminous coal in the United States continues to be consumed within the country, although the efforts to build up an export trade, particularly for the high-grade bituminous coals, has resulted in a considerable expansion of business done with foreign countries. The total quantity of coal exported from the United States increased from 20,326,619 short tons (18,148,767 long tons) in 1912 to 24,798,080 short tons (22,141,143 long tons) in 1913. Of the latter, 4,652,912 short tons (4,154,386 long tons) were anthracite, and 20,145,168 short tons (17,986,757 long tons) were bituminous. The imports in 1913 amounted to 1,583,560 short tons, which, added to the consumption of domestic coal, made the total consumption in that year 546,833,605 short tons, which is equivalent to 95.9 per cent of the domestic production. In this statement no account is taken of the stock on hand at the beginning and at the end of the year. The coal-mining industry is at best of a hand-to-mouth character, and stocks do not figure in the trade. Considerable quantities of anthracite are sometimes put into storage yards during the summer months, or in anticipation of extended suspensions, but they are usually disposed of in the same year that they are mined and stored, and affect neither production nor prices.

Most of the coal imported into the United States is classed as bituminous or shale, only a comparatively small quantity of anthracite being brought into this country. The imports of bituminous coal are principally to points on the Pacific coast and to the port of Boston, where considerable quantities of bituminous slack are imported from Canada and used at the Otto-Hoffmann coke ovens at Everett, near Boston. The exports of both anthracite and bituminous coal are principally to Canada.

Marketable product.—The statistics of coal production presented in these reports include not only the coal marketed, either by shipment to distant points, or sold locally, but that consumed by mine employees and by the mine owners in the operation of the colliers. The latter item is usually considered and reported as colliery consumption. There are occasional exceptions in the bituminous fields, where the operators, who use only slack, an otherwise waste product, do not report this item in their statements of production and do not deem it of any value; it is not considered as a portion of the mine product, nor is the miner paid for it in wages. Such exceptions are few and the quantity is negligible. The quantity of coal consumed in the manufacture of coke is also considered in this report.

The quantity of coal consumed in the manufacture of coke at the mines in 1913 was 49,458,320 short tons, against 47,958,332 short

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tons in 1912, an increase of 1,499,988 short tons, or 3.1 per cent, as compared with an increase of 6.31 per cent in the total production of bituminous coal, and of 6.66 per cent in the increase of anthracite and bituminous coal combined. The coal shipped to market, used in the manufacture of coke, and sold locally, amounted in 1913 to 548,764,919 short tons, as compared with 514,318,429 tons in 1912. This is usually considered the marketable product. The colliery consumption, which represents the difference between the marketable product and the total output, amounted in 1913 to 21,283,206 short tons. The colliery consumption in the anthracite region, consisting almost entirely of culm or waste material, averages something over 10 per cent of the total anthracite production. In 1913, out of a total output of 81,718,680 long tons, 8,581,694 long tons were used at the mines for steam and heat. The colliery consumption in the bituminous regions amounts to about 2.4 per cent of the total output, and in 1913 was 11,671,709 short tons out of a total production of 478,523,320 tons.

PRODUCTION.

STATISTICS FOR 1912 AND 1913.

The statistics of the production of coal in the United States in 1912 and 1913, by States, with the distribution of the product for consumption, are shown in the tables following.

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Coal production of the United States in 1912, by States, in short tons.

State.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Alabama	13,372,521	147,586	664,019	1,916,474	16,100,600	$20,829,252	$1.29	245	22,613
Arkansas	1,996,822	15,111	88,886	.....	2,100,819	3,582,789	1.71	157	4,536
California and Alaska	3,748	3,960	3,625	.....	11,333	26,441	2.33	184	52
Colorado	9,527,149	331,570	352,551	766,554	10,977,824	16,345,336	1.49	227	13,000
Georgia and North Carolina	108,135	1,504	6,141	111,923	227,703	338,926	1.49	254	450
Idaho and Nevada	500	2,414	50	.....	2,964	9,313	3.14	253	20
Illinois	55,304,530	2,793,861	1,786,835	.....	59,885,226	70,294,338	1.17	194	78,098
Indiana	14,179,686	704,229	401,803	.....	15,285,718	17,480,546	1.14	182	21,651
Iowa	6,519,307	590,206	180,016	.....	7,289,529	13,152,088	1.80	188	16,370
Kansas	6,662,834	129,978	192,595	775	6,986,182	11,324,130	1.62	202	11,646
Kentucky	15,159,515	632,629	438,378	259,999	16,490,521	16,854,207	1.02	201	24,204
Maryland	4,836,391	61,507	66,140	.....	4,964,038	5,839,079	1.18	259	6,162
Michigan	1,080,319	62,411	63,500	.....	1,206,230	2,399,451	1.99	183	3,113
Missouri	3,808,332	432,051	99,473	.....	4,339,856	7,633,864	1.76	206	9,704
Montana	2,818,503	82,052	147,940	.....	3,048,495	5,558,195	1.82	220	3,440
New Mexico	2,620,932	25,300	51,328	839,264	3,536,824	5,037,051	1.42	274	3,928
North Dakota	354,895	132,951	11,634	.....	499,480	765,105	1.53	232	622
Ohio	31,710,928	2,197,368	610,566	9,865	34,528,727	37,063,363	1.07	201	45,527
Oklahoma	3,415,958	74,059	185,401	.....	3,675,418	7,867,331	2.14	174	8,785
Oregon	14,361	19,646	7,630	.....	41,637	108,276	2.60	239	222
Pennsylvania, bituminous	116,477,708	3,850,895	3,657,367	37,879,518	161,865,488	169,370,497	1.05	252	165,144
Tennessee	5,802,779	85,654	137,382	447,413	6,473,228	7,379,903	1.14	234	10,309
Texas	2,084,254	41,760	62,598	.....	2,188,612	3,655,744	1.67	230	5,127
Utah	2,528,513	36,509	106,401	344,726	3,016,149	5,046,451	1.67	285	3,328
Virginia	6,027,712	107,657	182,870	1,528,399	7,846,638	7,518,576	.96	251	8,678
Washington	3,041,277	80,295	162,619	76,741	3,360,932	8,042,871	2.39	226	5,519
West Virginia	60,549,194	1,299,142	1,251,670	3,776,681	66,786,687	62,792,234	.94	266	68,248
Wyoming	6,993,263	83,388	291,473	.....	7,368,124	11,648,088	1.58	238	8,036
Total bituminous	377,000,066	13,935,693	11,210,891	47,958,332	450,104,982	517,983,445	1.15	223	548,632
Pennsylvania, anthracite	73,056,766	2,367,572	8,937,260	.....	84,361,598	177,622,626	2.11	231	174,030
Grand total	450,056,832	16,303,265	20,148,151	47,958,332	534,466,580	695,606,071	1.30	225	722,662

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Coal production of the United States in 1913, by States, in short tons.

State.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Alabama	15,094,036	163,180	752,686	1,668,620	17,678,522	$23,083,724	$1.31	255	24,552
Arkansas	2,117,358	7,987	108,762	.....	2,234,107	3,923,701	1.76	174	4,652
California and Alaska	16,432	2,256	8,223	.....	26,911	95,173	3.54	302	40
Colorado	7,136,633	365,216	328,249	1,402,412	9,232,510	14,035,090	1.52	229	11,990
Georgia	122,499	1,303	7,518	124,306	255,626	361,319	1.41	261	500
Idaho and Nevada	15	2,107	55	.....	2,177	5,285	2.43	183	12
Illinois	57,329,079	2,568,957	1,720,708	.....	61,618,744	70,313,605	1.14	189	79,529
Indiana	16,034,285	663,018	468,368	.....	17,165,671	19,001,881	1.11	190	22,235
Iowa	6,824,933	535,170	165,833	.....	7,525,936	13,496,710	1.79	195	15,757
Kansas	6,903,287	117,303	181,620	.....	7,202,210	12,036,292	1.67	197	12,479
Kentucky	18,029,826	739,622	454,718	392,434	19,616,600	20,516,749	1.05	212	26,332
Maryland	4,666,758	49,349	63,732	.....	4,779,839	5,927,046	1.24	248	5,645
Michigan	1,111,990	58,251	61,545	.....	1,231,786	2,455,227	1.99	188	3,305
Missouri	3,765,534	457,114	95,477	.....	4,318,125	7,468,308	1.73	187	10,418
Montana	3,022,298	111,130	107,545	.....	3,240,973	5,653,539	1.74	228	3,630
New Mexico	2,685,890	27,511	56,983	938,432	3,708,806	5,401,260	1.46	289	4,329
North Dakota	349,832	129,496	15,992	.....	495,320	750,652	1.52	221	641
Ohio	33,525,096	1,996,382	674,288	4,761	36,200,527	39,948,058	1.10	206	45,815
Oklahoma	3,841,096	59,475	265,199	.....	4,165,770	8,542,748	2.05	197	9,044
Oregon	31,582	8,617	5,864	.....	46,063	116,724	2.53	283	203
Pennsylvania, bituminous	127,958,404	4,122,430	3,806,529	37,893,854	173,781,217	193,039,806	1.11	267	172,196
Tennessee	6,125,821	78,796	160,180	538,987	6,903,784	7,883,714	1.14	241	11,263
Texas	2,358,578	12,188	58,378	.....	2,429,144	4,288,920	1.77	253	5,101
Utah	2,527,110	46,635	110,896	570,187	3,254,828	5,384,127	1.65	273	4,158
Virginia	6,615,481	83,432	175,792	1,953,363	8,828,068	8,952,653	1.01	280	9,162
Washington	3,520,554	62,702	175,937	118,698	3,877,891	9,243,137	2.38	260	5,794
West Virginia	64,812,324	1,309,163	1,335,229	3,852,266	71,308,982	71,872,165	1.01	234	74,786
Wyoming	7,003,990	83,673	305,403	.....	7,393,066	11,510,045	1.56	232	8,331
Total bituminous	403,530,711	13,862,463	11,671,709	49,458,320	478,523,203	565,307,658	1.18	232	571,899
Pennsylvania, anthracite	79,904,353	2,009,072	9,611,497	.....	91,524,922	195,181,127	2.13	257	175,745
Grand total	483,435,064	15,871,535	21,283,206	49,458,320	570,048,125	760,488,785	1.33	238	747,644

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The relative growth in the production of anthracite and bituminous coal in comparison with the increase in population is graphically illustrated in the accompanying diagram (fig. 2), the starting point for the

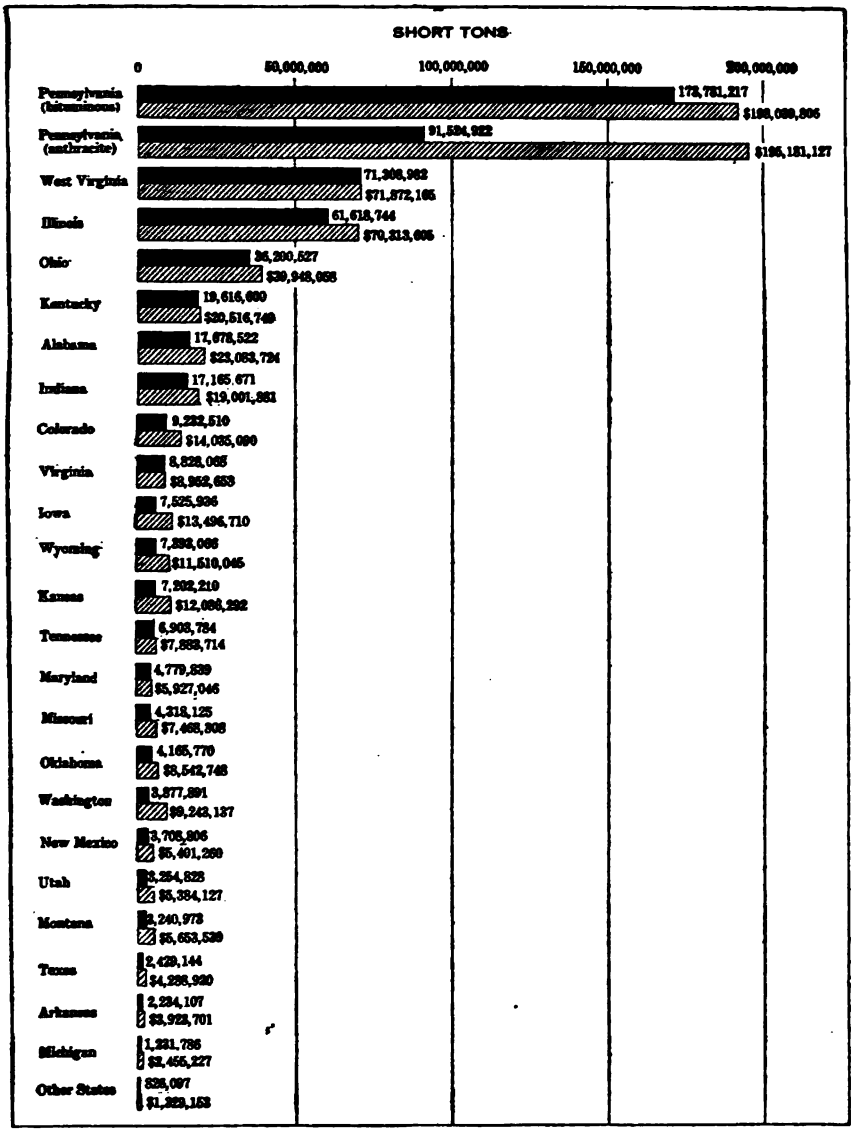

FIGURE 17.—Production of coal in the United States in 1913, by States, in short tons.

population being taken at 1870 when approximately 1 ton of coal was produced for each inhabitant, and when the production of anthracite and bituminous coal were about equal. It will be observed that the curve illustrating the production of anthracite (which has been practically

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eliminated as a manufacturing fuel and is now restricted mainly to domestic consumption) follows a line approximately parallel with the curve of population, and has been fairly regular in its course. The

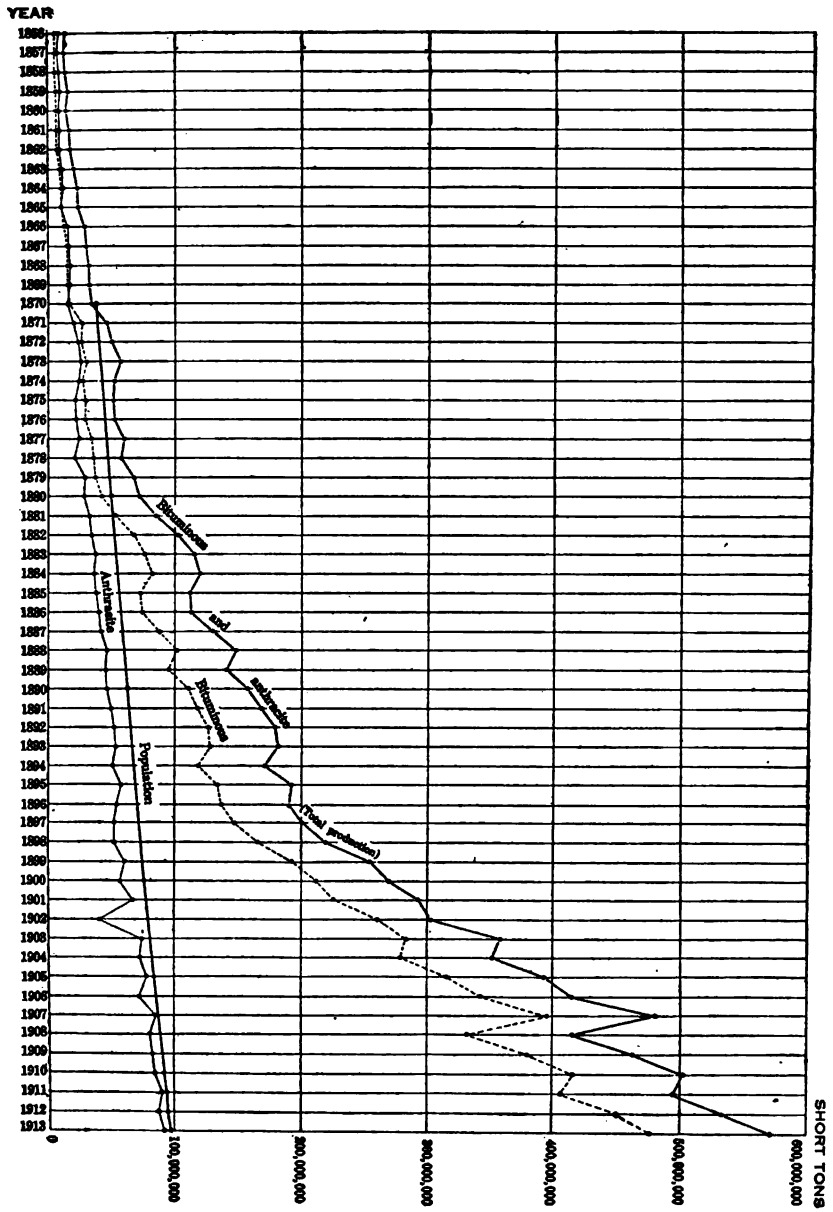

FIGURE 18.—Yearly production of anthracite and bituminous coal from 1856 to 1913, in short tons.

variations in the production of anthracite have been due principally to labor troubles and not, as is the case with bituminous coal, to trade conditions. The most violent change in anthracite curve was in 1902

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when, because of the great strike of that year, the production dropped below that of any year since 1886. The breaks in the upward trend of bituminous-coal production are noted in the years of business depression, particularly in 1908, when the production of anthracite was scarcely affected. During the last 25 years the production of bituminous coal has grown by leaps and bounds, and there has in this period been only one instance when it has taken two years to recover from the effects of a business depression. This was in 1908 and 1909 and followed the boom year, 1907, when the largest increase over a preceding year in the history of the industry had been recorded. In the last 25 years, or since 1888, the production of anthracite has increased from 46,619,564 short tons to 91,524,922 tons, or nearly 100 per cent, while the production of bituminous coal has increased from 102,040,093 tons to 478,523,203 tons, or nearly 370 per cent. The total production of coal in the United States at the present time is nearly four times what it was 25 years ago. In this rapid development the United States has far outstripped the other countries of the world. The rate of increase in the production of all kinds of coal in Great Britain and France has been about the same as that of anthracite in Pennsylvania. Germany's production has increased at a much more rapid rate, but at a considerably slower rate than the production of bituminous coal or the total production in the United States.

There is good reason for the opinion held by many that the curve of production of anthracite will not continue to show an upward movement for many years longer, or that, if continued for any length of time, it will be on a gradually lessening scale until the inevitable period of practical constancy and then decline begins. In other words, the maximum yearly production of anthracite is almost attained and the industry may be said to be "in its prime." Some authorities are of the opinion that before the period of decline begins an output of 100,000,000 long tons (112,000,000 short tons) a year will be mined. This would mean an increase over the record for 1913 of about 18,000,000 long tons (20,000,000 short tons). To attain this may not be physically impossible, but it seems improbable. The number of days (257) worked in the anthracite mines of Pennsylvania in 1913 was more than in any year in the history of the region. The average production for each working day was approximately 318,000 long tons. At this rate, if the mines had been worked full 300 days in the year, the production would have amounted to about 95,400,000 long tons. At the daily rate of production in 1912 (326,000 tons a day), had the mines been operated full 300 days the output would have amounted to 97,800,000 long tons. It is not probable, however, that the average working time of 1913 will be much exceeded; some days of idleness are necessary and inevitable, and as there is little, if any, virgin territory to be developed, the output can not be expected to show very material increase in the years to come.

The average daily production of bituminous coal in 1913 was approximately 2,060,000 short tons, from which it appears by the same method of deduction, that the capacity of the bituminous mines, with the same number of employees as in 1913, if worked full 300 days in the year, would be about 618,000,000 tons.

In the following table the production and value of anthracite and bituminous coal in the United States are given for each five years

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from 1870 to 1910, and in 1911, 1912, and 1913, in both long and short tons:

Production of coal in the United States each five years from 1870 to 1910 and in 1911, 1912, and 1913.

Year.	Pennsylvania anthracite.			Bituminous coal.		
	Quantity.		Value.	Quantity.		Value.
	Long tons.	*Short tons.*		*Long tons.*	*Short tons.*	
1870	13,985,960	15,664,275	$38,360,616	15,510,094	17,371,305	$40,585,915
1875	20,076,577	22,485,766	[a] 44,000,000	26,662,994	29,862,554	[a] 55,000,000
1880	25,580,189	28,649,812	42,196,678	38,242,641	42,831,758	58,443,718
1885	34,228,548	38,335,974	76,671,948	65,021,715	72,824,321	82,347,648
1890	41,489,858	46,468,641	66,383,772	99,377,073	111,302,322	110,420,801
1895	51,785,122	57,999,337	82,019,272	120,641,244	135,118,193	115,779,771
1900	51,221,353	57,367,915	85,757,851	189,567,957	212,316,112	220,930,313
1905	69,339,152	77,659,850	141,879,000	281,306,058	315,062,785	334,658,294
1910	75,433,246	84,485,236	160,275,302	372,420,663	417,111,142	469,281,719
1911	80,771,488	90,464,067	175,189,392	362,417,017	405,907,059	451,375,819
1912	75,322,855	84,361,598	177,622,626	401,879,448	450,104,982	517,983,445
1913	81,718,680	91,524,922	195,181,127	427,252,860	478,523,203	565,307,658

Year.	Total.		
	Quantity.		Value.
	Long tons.	*Short tons.*	
1870	29,496,054	33,035,580	$78,946,531
1875	46,739,571	52,348,320	[a] 99,000,000
1880	63,822,830	71,481,570	100,640,396
1885	99,250,263	111,160,295	159,019,596
1890	140,866,931	157,770,963	176,804,573
1895	172,426,366	193,117,530	197,799,043
1900	240,789,310	269,684,027	306,688,164
1905	350,645,210	392,722,635	476,537,294
1910	447,853,909	501,596,378	629,557,021
1911	443,188,505	496,371,126	626,565,211
1912	477,202,303	534,466,580	695,606,071
1913	508,971,540	570,048,125	760,488,785

[a] Estimated.

As shown in the following table, there were only three States whose coal production exceeds half a million tons, in which the ouput in 1913 was less than in 1912. The three exceptions to the general increase in production among the important States were Colorado, Maryland, and Missouri, one of these being in the eastern province, one in the central, and one in the Rocky Mountain. The decreased production of Colorado was due solely to labor troubles, brought on by an attempt to organize the mine workers in the Trinidad field, the most important coal producing area in the State. In Maryland the smaller production is attributed to the gradual exhaustion of the larger mines operating on the principal source of supply, "the Maryland Big Vein," and the decreasing production is likely to continue until conditions warrant extensive development of the lower and thinner beds whose aggregate reserves largely exceed the original contents of the famous "Big Vein." The decrease in Missouri was insignificant (one half of 1 per cent) and was due to exceptionally mild weather in February and March, which cut down the production for those two months 135,000 tons, compared with the same period in 1912.

The largest increase was in the production of bituminous coal in Pennsylvania, which showed a gain of 11,915,729 short tons, or 7.36 per cent, in quantity and of $23,669,309, or 14 per cent, in value. Second in the quantity of increase was Pennsylvania anthracite, whose production increased 6,395,825 long tons (7,163,324 short

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tons), or 8.5 per cent in quantity and $17,558 501 or 9.9 per cent in value. West Virginia came next with an increase of 4,522,295 short tons or 6.8 per cent in quantity and of $9,079,931, or 14.5 per cent in value. Kentucky had the largest percentage of increase of the important coal-producing States, with a gain of 3,126,079 short tons or 19 per cent in quantity and of $3,662,542, or 21.7 per cent in value. It will be noted that in each of these instances the percentage of increase in value was more than in that of quantity of coal produced. Indiana and Illinois were two notable exceptions to the larger proportionate gain in value the former showing an increase of 1,879,953 tons, or 12.3 per cent in quantity and of $1,521,335, or 8.7 per cent in value, while Illinois gained 1,733,518 tons, or 2.9 per cent in quantity and only $19,267, or 0.03 per cent in value. Ohio showed an increase of 1,671,800 tons, or 4.8 per cent in quantity and of $2,864,695, or 7.7 per cent in value; Alabama, a gain of 1,577,922 short tons, or 9.8 per cent in quantity and of $2,254,472, or 10.8 per cent in value, and Virginia, with an increase in quantity of 981,430 tons, 12.5 per cent, gained $1,434,077, or 19 per cent in value. Iowa and Oklahoma, of the eastern province, Montana and Utah, in the Rocky Mountain province, and Washington and Oregon, of the Pacific province, showed smaller relative gains in value than in production, and Wyoming, one of the Rocky Mountain States, was the only one to show an increase in production and a decrease in value. Georgia, the least important of the Appalachian States, was the only one of that region to show a relative loss in value.

The total production and value in the last five years, by States, with the increase and decrease in 1913, as compared with 1912, are shown in the following table:

Quantity and value of coal produced in the United States, 1909–1913, in short tons.

State.	1909		1910	
	Quantity.	Value.	Quantity.	Value.
Alabama	13,703,450	$16,306,236	16,111,462	$20,236,853
Arkansas	2,377,157	3,523,139	1,905,958	2,979,213
California and Alaska	48,636	107,342	12,164	33,336
Colorado	10,716,936	14,298,012	11,973,736	17,026,934
Georgia and North Carolina	[a] 211,196	[a] 298,792	[a] 177,245	[a] 259,122
Idaho	4,553	19,459	4,448	17,426
Illinois	50,904,990	53,522,014	45,900,246	52,405,897
Indiana	14,834,359	15,154,681	18,389,815	20,813,659
Iowa	7,757,762	12,793,628	7,928,120	13,903,913
Kansas	6,986,478	10,083,384	4,921,451	7,914,709
Kentucky	10,697,384	10,079,917	14,623,319	14,405,887
Maryland	4,023,941	4,471,731	5,217,125	5,835,058
Michigan	1,784,992	3,199,351	1,534,967	2,930,771
Missouri	3,756,530	6,183,626	2,982,433	5,328,285
Montana	2,553,940	5,036,942	2,920,970	5,329,322
New Mexico	2,801,128	3,619,744	3,508,321	4,877,151
North Dakota	422,047	645,142	399,041	595,139
Ohio	27,939,641	27,789,010	34,209,668	35,932,288
Oklahoma	3,119,377	6,253,367	2,646,226	5,987,947
Oregon	87,276	235,085	67,533	235,229
Pennsylvania, bituminous	137,966,791	130,085,237	150,521,526	153,029,510
Tennessee	6,358,645	6,920,564	7,121,390	7,925,350
Texas	1,824,440	3,141,945	1,892,176	3,160,965
Utah	2,266,899	3,751,810	2,517,809	4,224,556
Virginia	4,752,217	4,251,056	6,507,997	5,877,486
Washington	3,602,263	9,158,999	3,911,899	9,764,465
West Virginia	51,849,220	44,661,716	61,671,019	56,665,061
Wyoming	6,393,109	9,896,948	7,533,088	11,706,187
Total bituminous	379,744,257	405,486,777	417,111,142	469,281,719
Pennsylvania anthracite	81,070,359	149,181,587	84,485,236	160,275,302
Grand total	460,814,616	554,668,364	501,596,378	629,557,021

[a] Georgia only.

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Quantity and value of coal produced in the United States, 1909–1913, in short tons—Con.

State.	1911		1912	
	Quantity.	Value.	Quantity.	Value.
Alabama	15,021,421	$19,079,949	16,100,600	$20,829,252
Arkansas	2,106,789	3,396,849	2,100,819	3,582,789
California and Alaska	11,647	23,297	11,333	26,441
Colorado	10,157,383	14,747,764	10,977,824	16,345,336
Georgia and North Carolina	165,330	246,448	227,703	338,926
Idaho	a 1,821	a 4,872	2,964	9,313
Illinois	53,679,118	59,519,478	59,885,226	70,294,338
Indiana	14,201,355	15,326,808	15,285,718	17,480,546
Iowa	7,331,648	12,663,507	7,289,529	13,152,088
Kansas	6,178,728	9,473,572	6,986,182	11,324,130
Kentucky	14,049,703	14,008,458	16,490,521	16,854,207
Maryland	4,685,795	5,197,066	4,984,038	5,839,079
Michigan	1,476,074	2,791,461	1,206,230	2,399,451
Missouri	3,836,107	6,603,066	4,339,856	7,633,864
Montana	2,976,358	5,342,168	3,048,495	5,558,195
New Mexico	3,148,158	4,525,925	3,536,824	5,037,051
North Dakota	502,628	720,489	499,480	765,105
Ohio	30,759,986	31,810,123	34,628,727	37,083,363
Oklahoma	3,074,242	6,291,494	3,675,418	7,867,331
Oregon	46,661	108,033	41,637	108,276
Pennsylvania, bituminous	144,561,257	146,154,952	161,985,488	169,370,497
Tennessee	6,433,156	7,209,734	6,473,228	7,379,903
Texas	1,974,593	3,273,288	2,188,612	3,655,744
Utah	2,513,175	4,248,666	3,016,149	5,046,451
Virginia	6,864,667	6,254,804	7,846,638	7,518,576
Washington	3,572,815	8,174,170	3,360,932	8,042,871
West Virginia	59,831,580	53,670,515	66,796,687	62,792,234
Wyoming	6,744,864	10,508,863	7,388,124	11,648,088
Total bituminous	405,907,059	451,375,819	450,104,982	517,983,445
Pennsylvania anthracite	90,464,067	175,189,392	84,361,598	177,622,626
Grand total	496,371,126	626,565,211	534,466,580	695,606,071

State.	1913		Increase (+) or decrease (−), 1913.		Percentage of increase or decrease, 1913.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	17,678,522	$23,063,724	+ 1,577,922	+$2,234,472	+ 9.80	+ 10.82
Arkansas	2,234,107	3,923,701	+ 133,288	+ 340,912	+ 6.34	+ 9.52
California and Alaska	26,911	95,173	+ 15,578	+ 68,732	+137.46	+259.94
Colorado	9,232,510	14,035,090	− 1,745,314	− 2,310,246	− 15.90	− 14.13
Georgia	255,626	361,319	+ 27,923	+ 22,393	+ 12.26	+ 6.61
Idaho and Nevada	2,177	5,285	− 787	− 4,028	− 26.55	− 43.25
Illinois	61,618,744	70,313,605	+ 1,733,518	+ 19,267	+ 2.89	+ .03
Indiana	17,165,671	19,001,881	+ 1,879,953	+ 1,521,335	+ 12.30	+ 8.70
Iowa	7,525,936	13,496,710	+ 236,407	+ 344,622	+ 3.24	+ 2.62
Kansas	7,202,210	12,036,292	+ 216,028	+ 712,162	+ 3.09	+ 6.29
Kentucky	19,616,600	20,516,749	+ 3,126,079	+ 3,662,542	+ 18.96	+ 21.73
Maryland	4,779,839	5,927,046	− 184,199	+ 87,967	− 3.71	+ 1.51
Michigan	1,231,786	2,455,227	+ 25,556	+ 55,776	+ 2.12	+ 2.32
Missouri	4,318,125	7,468,308	− 21,731	− 165,556	− .50	− 2.17
Montana	3,240,973	5,653,539	+ 192,478	+ 95,344	+ 6.31	+ 1.72
New Mexico	3,708,806	5,401,260	+ 171,982	+ 364,209	+ 4.86	+ 7.23
North Dakota	495,320	750,652	− 4,160	− 14,453	− .83	− 1.89
Ohio	36,200,527	39,948,058	+ 1,671,800	+ 2,864,695	+ 4.84	+ 7.73
Oklahoma	4,165,770	8,542,748	+ 490,352	+ 675,417	+ 13.34	+ 8.59
Oregon	46,063	116,724	+ 4,426	+ 8,448	+ 10.63	+ 7.80
Pennsylvania, bituminous	173,781,217	193,039,806	+11,915,729	+23,669,309	+ 7.36	+ 13.97
Tennessee	6,903,784	7,883,714	+ 430,556	+ 503,811	+ 6.65	+ 6.83
Texas	2,429,144	4,288,920	+ 240,532	+ 633,176	+ 10 99	+ 17.32
Utah	3,254,828	5,384,127	+ 238,679	+ 337,676	+ 7.91	+ 6.69
Virginia	8,828,068	8,952,653	+ 981,430	+ 1,434,077	+ 12.51	+ 19.07
Washington	3,877,891	9,243,137	+ 516,959	+ 1,200,266	+ 15.38	+ 14.92
West Virginia	71,308,982	71,872,165	+ 4,522,295	+ 9,079,931	+ 6.77	+ 14.46
Wyoming	7,393,066	11,510,045	+ 24,942	− 138,043	+ .33	− 1.19
Total bituminous	478,523,203	565,307,658	+28,418,221	+47,324,213	+ 6.31	+ 9.14
Pennsylvania, anthracite	91,524,922	195,181,127	+ 7,163,324	+17,558,501	+ 8.49	+ 9.89
Grand total	570,048,125	760,488,785	+35,581,545	+64,882,714	+ 6.66	+ 9.33

a Includes production of Nevada.

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PRODUCTION OF COAL IN THE UNITED STATES FROM THE EARLIEST TIMES TO THE CLOSE OF 1913.

The earliest mention of coal in the territory which afterwards became the United States is recorded in the journal of Father Louis Hennepin, a French missionary, who in 1679 recorded the site of a "cole" mine on Illinois River, near the present city of Ottawa, Hennepin having passed through that region 10 years before. The next mention of bituminous coal in the United States territory is in the writings of Col. William Boyd, who in a report made to the Virginia Assembly in 1701, mentioned the discovery of coal in what is now known as the Richmond Basin, near Richmond, Va. The first actual mining of coal was from this Virginia locality. Authorities differ as to the date the first coal was mined, but it was some time between 1720 and 1750. During the Revolutionary War the mining of coal in the Richmond Basin was a comparatively important industry. Ohio probably ranks second in priority of production, as coal was discovered there in 1755, but the records of production date back only to 1838. The earliest record of coal mining in the bituminous regions of Pennsylvania is for the year 1760, five years after the discovery of coal in Ohio, when Capt. Thomas Hutchins visited Fort Pitt (now Pittsburgh) and found a coal mine on the opposite side of Monongahela River, the product being used by the resident garrison. In 1768 the Penn Proprietaries purchased from the Six Nations the whole of the bituminous coal field of Pennsylvania except that portion which lies northward of Kittanning, which was purchased 16 years later. The mining of anthracite began in the last half of the eighteenth century. Its earliest discovery was in 1762 when settlers from Connecticut found "stone" coal in the Wyoming Valley. The first use of it, so far as known, was made in 1768. It was first used in a forge in 1769. Mining may be said to have begun near Pittston in 1775, and in 1776 to 1780 anthracite was mined on the banks of Susquehanna River near Wilkes-Barre and shipped by barges to Carlisle and Columbia. Anthracite was used in making nails in 1788, all of these instances occurring in the Wyoming region, the discovery of coal in that region having antedated the discovery in the Schuylkill region by 28 years. In 1807 a shipment of 55 long tons of anthracite was made by Abijah Smith & Co., from Plymouth to Columbia, and it is estimated that from 1807 to 1820, when the first shipments were made from the Lehigh region, about 12,000 tons had already been shipped from the Wyoming Valley. Coal was discovered in the Lehigh region in 1791, and the first anthracite company, the Lehigh Coal Mining Co. (now the Lehigh Coal & Navigation Co.), was organized in 1792. In 1820 the shipments from the Lehigh region began, 13 years after the first shipments were made from the Wyoming region. In 1814, six years before the Lehigh region was opened, some coal was mined at Carbondale and shipped via Lackawaxen and Delaware rivers to Philadelphia. The records of the bureau of anthracite statistics began in 1820, when the first rail shipments were made from Lehigh region, one long ton for each day of the year. In addition to having the credit for priority of discovery and mining of anthracite, the Wyoming region, although the latest of the three large

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regions to report regular shipments of coal has contributed considerably more than one-half of the total quantity of coal sent out of the anthracite fields of Pennsylvania. According to the reports of the bureau of anthracite statistics, the total quantity of anthracite

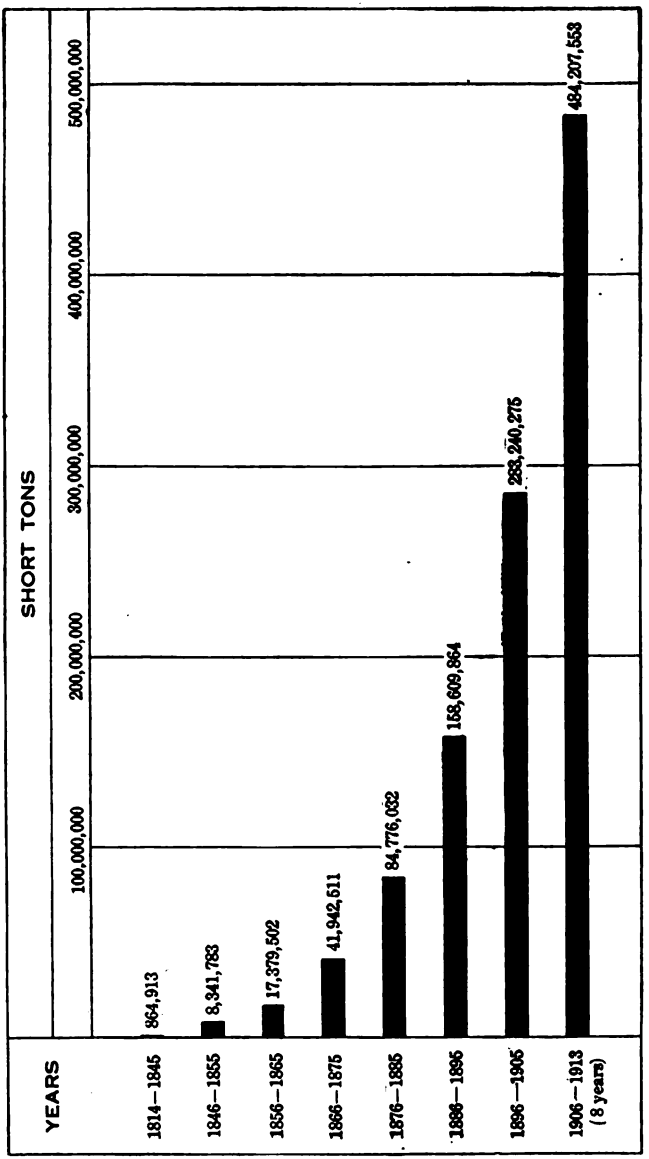

FIGURE 19.—Average yearly production of coal in the United States for 1814–1845 and for each decade since 1845, in short tons.

shipped, up to the close of 1913, was approximately 1,952,030,000 tons, of which 1,036,760,000 tons had been sent out from the Wyoming region. The following table shows the total production of anthracite in Pennsylvania, in short tons, since 1807, the total production of bitu-

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minous coal since 1820, and the total annual production up to the close of 1913. During the period covered by the table the total production of anthracite in Pennsylvania has amounted to 2,446,696,010 short tons; the country's production of bituminous coal to 7,397,551,833 tons, and the aggregate production to 9,844,247,843 tons. Of the grand total the anthracite mines of Pennsylvania have contributed a little less that 25 per cent and the rest of the country a little more than 75 per cent. The annual production of coal in each State from the time of earliest record until the close of 1913 is given in connection with the discussion of production in the several States. (See also chart in pocket.)

Production of coal in the United States from 1807 to the close of 1913, in short tons.

Year.	Pennsylvania anthracite.	Bituminous.	Total.	Year.	Pennsylvania anthracite.	Bituminous.	Total.
1807-1820	12,000	3,000	15,000	1871.....	19,342,057	27,543,023	46,885,080
				1872.....	24,233,166	27,220,233	51,453,399
1821.....	1,322	.....	1,322	1873.....	26,152,837	31,449,643	57,602,480
1822.....	4,583	54,000	58,583	1874.....	24,818,790	27,787,130	52,605,920
1823.....	8,563	60,000	68,563	1875.....	22,485,766	29,862,554	52,348,320
1824.....	13,685	67,040	80,725				
1825.....	42,988	75,009	117,988	1876.....	22,793,245	30,486,755	53,280,000
				1877.....	25,660,316	34,841,444	60,501,760
1826.....	59,194	88,720	147,914	1878.....	21,689,682	36,245,918	57,935,600
1827.....	78,151	94,000	172,151	1879.....	30,207,793	37,898,006	68,105,799
1828.....	95,500	100,408	195,908	1880.....	28,649,812	42,831,758	71,481,570
1829.....	138,086	102,000	240,086				
1830.....	215,272	104,800	320,072	1881.....	31,920,018	53,961,012	85,881,030
				1882.....	35,121,256	68,429,933	103,551,189
1831.....	217,842	120,100	337,942	1883.....	38,456,845	77,250,680	115,707,525
1832.....	447,550	146,500	594,050	1884.....	37,156,847	82,998,704	120,155,551
1833.....	600,907	133,750	734,657	1885.....	38,335,974	72,824,321	111,160,295
1834.....	464,015	136,500	600,515				
1835.....	690,854	134,000	824,854	1886.....	39,035,446	74,644,981	113,680,427
				1887.....	42,068,197	88,562,314	130,650,511
1836.....	842,832	142,000	984,832	1888.....	46,619,564	102,040,093	148,659,657
1837.....	1,071,151	182,500	1,253,651	1889.....	45,546,970	95,682,543	141,229,513
1838.....	910,075	445,452	1,355,527	1890.....	46,468,641	111,302,322	157,770,963
1839.....	1,008,322	552,038	1,560,360				
1840.....	967,108	1,102,931	2,070,039	1891.....	50,665,431	117,901,238	168,566,669
				1892.....	52,472,504	126,856,567	179,329,071
1841.....	1,182,441	1,108,700	2,291,141	1893.....	53,967,543	128,385,231	182,352,774
1842.....	1,365,563	1,244,494	2,610,057	1894.....	51,921,121	118,820,405	170,741,526
1843.....	1,556,753	1,504,121	3,060,874	1895.....	57,999,337	135,118,193	193,117,530
1844.....	2,009,207	1,672,045	3,681,252				
1845.....	2,480,032	1,829,872	4,309,904	1896.....	54,346,081	137,640,276	191,986,357
				1897.....	52,611,680	147,617,519	200,229,199
1846.....	2,887,815	1,977,707	4,865,522	1898.....	53,382,644	166,593,623	219,976,267
1847.....	3,561,005	1,735,062	5,286,067	1899.....	60,418,005	193,323,187	253,741,192
1848.....	3,805,942	1,968,032	5,773,974	1900.....	57,367,915	212,316,112	269,684,027
1849.....	3,995,334	2,453,497	6,448,831				
1850.....	4,138,164	2,880,017	7,018,181	1901.....	67,471,667	225,828,149	293,299,816
				1902.....	41,373,595	260,216,844	301,590,439
1851.....	5,481,065	3,253,460	8,734,525	1903.....	74,607,068	282,749,348	357,356,416
1852.....	6,151,957	3,664,707	9,816,664	1904.....	73,156,709	278,659,689	351,816,398
1853.....	6,400,426	4,169,862	10,570,288	1905.....	77,659,850	315,062,785	392,722,635
1854.....	7,394,875	4,582,227	11,977,102				
1855.....	8,141,754	4,784,919	12,926,673	1906.....	71,282,411	342,874,867	414,157,278
				1907.....	85,604,312	394,759,112	480,363,424
1856.....	8,534,779	5,012,146	13,546,925	1908.....	83,268,754	332,573,944	415,842,698
1857.....	8,186,567	5,153,622	13,340,189	1909.....	81,070,359	379,744,257	460,814,616
1858.....	8,426,102	5,548,376	13,974,478	1910.....	84,485,236	417,111,142	501,596,378
1859.....	9,619,771	6,013,404	15,633,175				
1860.....	8,115,842	6,494,200	14,610,042	1911.....	90,464,067	405,907,059	496,371,126
				1912.....	84,361,598	450,104,982	534,466,580
1861.....	9,799,654	6,688,358	16,488,012	1913.....	91,524,922	478,523,203	570,048,125
1862.....	9,696,110	7,790,725	17,485,835				
1863.....	11,785,320	9,533,742	21,319,062		2,446,696,010	7,397,551,833	9,844,247,843
1864.....	12,538,649	11,066,474	23,605,123				
1865.....	11,891,746	11,900,427	23,792,173				
1866.....	15,651,183	13,352,400	29,003,583				
1867.....	16,002,109	14,722,313	30,724,422				
1868.....	17,003,405	15,858,555	32,861,960				
1869.....	17,083,134	15,821,226	32,904,360				
1870.....	15,664,275	17,371,305	33,035,580				

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COAL FIELDS OF THE UNITED STATES.

The coal areas of the United States are divided, for the sake of convenience, into two great divisions—anthracite and bituminous.

The areas in which anthracite is produced are confined almost exclusively to the eastern part of Pennsylvania, and usually when the anthracite fields of the United States are referred to those of eastern Pennsylvania are meant. These fields are included in the counties of Susquehanna, Lackawanna, Luzerne, Carbon, Schuylkill, Columbia, Northumberland, Dauphin, and Sullivan, and underlie an area of about 480 square miles. In addition to these well-known anthracite fields of Pennsylvania there are two small areas in the Rocky Mountain region where the coal has been locally anthracited, although the production from these districts has never amounted to as much as 100,000 tons in any one year. One of these localities is in Gunnison County, Colo., and the other in Santa Fe County, N. Mex. The coal, although only locally metamorphosed, is a true anthracite and of a good quality. In previous years some coal which was classed as anthracite was mined and sold in New England. The productive area was confined to the eastern part of Rhode Island and the counties of Bristol and Plymouth in Massachusetts.

The bituminous and lignite fields are scattered widely over the United States and include an area of more than 450,000 square miles. The previous classification of these coal areas published in earlier volumes of the report Mineral Resources of the United States has been changed as a result of conferences among the geologists working under Marius R. Campbell on the economic geology of coal. The areas are divided, primarily, into six provinces, as follows:

(1) The eastern province, which includes all of the bituminous areas of the Appalachian region; the Atlantic coast region, which includes the Triassic fields near Richmond and the Deep River and Dan River fields of North Carolina, and also the anthracite region of Pennsylvania. (2) The Gulf province, which includes the lignite fields of Alabama, Mississippi, Louisiana, Arkansas, and Texas. (3) The interior province, which includes all the bituminous areas of the Mississippi Valley region and the coal fields of Michigan. This province is subdivided into the eastern region, which embraces the coal fields of Illinois, Indiana, and western Kentucky; the western region, which includes the fields of Iowa, Missouri, Nebraska, Kansas, Arkansas, and Oklahoma; and the southwestern region, which includes the coal fields of Texas. The Michigan fields are designated as the northern region of the interior province. (4) The northern or Great Plains province, which includes the lignite areas of North Dakota and South Dakota, and the bituminous and subbituminous areas of northeastern Wyoming and of northern and eastern Montana. (5) The Rocky Mountain province, which includes the coal fields of the portions of Montana and Wyoming which are in the mountainous districts of those States, and all the coal fields of Utah, Colorado, and New Mexico. (6) The Pacific coast province, which includes all of the coal fields of California, Oregon, and Washington.

The report on the production of coal in 1910 contains brief descriptions of the coal fields of the several States and maps of the known coal areas. Copies of this report are still available and may be obtained free of charge upon application to the Director of the United

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States Geological Survey, Washington, D. C. The geologic work done by the Geological Survey in the coal-mining States of the Rocky Mountain region has greatly advanced the knowledge of the coal reserves in those States, and the areas now known to contain workable coal exceed by many square miles and the reserves by many million tons the earlier estimates published in this series of reports. From the information thus obtained Mr. Campbell has revised the table showing the areas and the original supplies. This revision indicates that the total coal reserves of the United States exceed by about 17 per cent the previously compiled estimates. Some of this increase is in the States of the western and southwestern regions and in the State of Washington, but most of them are in the public-land States of the Rocky Mountain and northern or Great Plains provinces. In the table presented herewith the Rocky Mountain and Great Plains States are shown to have contained originally a total of 2,514,415,900,000 short tons of coal. The report for 1912 (the revised figures were not then available) showed that these areas were estimated to contain about 1,970,000,000,000 tons. The known coal areas of the United States aggregate a total of 339,887 square miles, to which may be added 89,482 square miles supposed to contain workable coal, but knowledge of them is not sufficient to warrant a definite statement to that effect. In addition, there are 28,470 square miles where the coal lies at depths of 3,000 feet or more, and is not considered available under present conditions. In the 1912 and preceding reports the known coal areas of the United States were stated to embrace 310,296 square miles, and the unknown areas about 160,000 square miles, but it is seen that definite knowledge of the coal contents has been extended over an additional area of nearly 30,000 square miles, and that the areas about which little is known have been nearly cut in half. The supply of coal before mining began is now estimated to have been 3,554,383,400,000 tons. Classified according to the character of the coal, the original supply consisted of 21,000,000,000 short tons of anthracite (exclusive of the small areas in Colorado and New Mexico); 1,834,100,000 tons of semianthracite; 1,444,036,500,000 tons of bituminous coal; 47,913,500,000 tons of semibituminous coal; 948,084,900,000 tons of subbituminous coal, or black lignite; and 1,087,514,400,000 tons of lignite, or brown coal. The coal lying from 3,000 to 6,000 feet below the surface is estimated at about 675,000,000,000 short tons.

It will be observed from these figures that nearly 60 per cent of the entire reserve is composed of subbituminous and lignite, and that barely 40 per cent is represented by the higher grades—anthracite, semianthracite, and bituminous coal.

The total production at the close of 1913 has amounted to 2,446,696,010 short tons of anthracite and 7,397,551,833 short tons of bituminous coal, an aggregate of 9,844,247,843 short tons. It is usual to consider that for every ton of coal that has been mined and marketed a half ton has been lost through necessary waste in mining. In the early history of mining in both the anthracite and bituminous regions the percentage of loss was considerably more than half a ton for every ton mined. In the anthracite region it was estimated by the Anthracite Waste Commission, which made its report in 1893, that the recovery was only 40 per cent, or, in other words, a ton and

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a half was lost for every ton sold. At the present time the recovery in the anthracite region is from 60 to 65 per cent, so that conditions are reversed, and for every ton of coal lost a ton and a half is sold or used. In some parts of the bituminous regions the recovery approaches 100 per cent. In other cases it is less than 50 per cent, where the beds are very thick or lie at great depth and it is necessary to leave large quantities of coal in pillars to support the roof. Half a ton of coal lost for each ton mined is doubtless a fair average. The exhaustion in the anthracite region of Pennsylvania is probably equivalent to double the production; that is, for every ton of coal mined 1 ton has been lost, and the exhaustion in the anthracite region consequently amounts to 4,847,000,000 tons. In the mines of the bituminous fields, estimating a half ton lost for every ton produced, the exhaustion is equivalent to about 11,100,000,000 tons; hence the total exhaustion amounts to about 16,000,000,000 short tons, or about 0.5 of 1 per cent of the original supply. In other words, the quantity of coal still remaining to be mined amounts to approximately 3,527,700,000,000 tons, or a little more than 99.5 per cent of the original supply. Upon the same basis of a two-thirds recovery, something over 2,250,000,000,000 tons of coal are still available, a little less than 4,000 times the rate of production in 1913.

The following table shows the area known to contain coal in the various States, by fields, the estimated original supply, the total production of each State and field in 1913, the total production in each to the close of 1913, and the estimated supply still available:

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Areas of the coal fields by States, estimates of original and present supply, and the production to the close of 1913.

	Area.	Estimated original supply.	Production in 1913.	Total production to close of 1913.	Total exhaustion to close of 1913.	Estimated available supply.
ANTHRACITE.	*Square miles.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Pennsylvania	480	21,000,000,000	91,524,922	2,446,696,010	4,847,000,000	16,153,000,000
Colorado and New Mexico	(a)	(a)	(a)	.....	.....	.....
Total	480	21,000,000,000	91,524,922	2,446,696,010	4,847,000,000	16,153,000,000
BITUMINOUS.[b]						
Eastern province.						
Atlantic coast region:						
Virginia	150	(c)	(c)	(c)	(c)	(c)
North Carolina	60	200,000,000	.....	477,125	715,700	199,284,300
Appalachian region:						
Pennsylvania	14,200	112,574,000,000	173,781,217	2,731,945,059	4,100,000,000	108,474,000,000
Ohio	12,660	93,967,900,000	36,200,527	682,678,546	1,024,000,000	92,943,900,000
Maryland	455	8,044,000,000	4,779,839	175,553,679	263,500,000	7,780,500,000
Virginia	1,750	22,500,000,000	8,828,068	96,287,781	134,500,000	22,365,500,000
West Virginia	17,000	151,544,900,000	71,308,982	787,543,870	1,181,300,000	150,363,600,000
Eastern Kentucky	10,270	67,787,000,000	11,098,960	93,423,911	140,000,000	67,647,000,000
Tennessee	4,400	25,665,000,000	6,903,784	123,793,965	186,000,000	25,479,000,000
Georgia	167	933,000,000	255,626	9,425,298	14,200,000	918,800,000
Alabama	8,455	67,583,000,000	17,678,522	254,954,358	382,400,000	67,200,600,000
Total	69,357	550,598,800,000	330,835,525	4,955,706,467	7,425,900,000	543,172,900,000
Interior province.						
Northern region:						
Michigan	11,000	12,000,000,000	1,231,786	22,911,711	34,400,000	11,965,600,000
Eastern region:						
Indiana	6,500	53,051,000,000	17,165,671	251,632,098	377,500,000	52,673,500,000
Western Kentucky	6,400	55,540,000,000	8,517,640	114,704,743	172,000,000	55,368,000,000
Illinois	35,600	201,399,800,000	61,618,744	965,516,323	1,448,300,000	199,951,500,000
Total	48,500	309,990,800,000	87,302,055	1,331,853,164	1,997,800,000	307,993,000,000

a Included in Rocky Mountain and Northern Great Plains provinces.
b Includes brown coal or lignite, semianthracite, semibituminous, etc., and scattering lots of anthracite.
c Included in production of Appalachian region.

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Areas of the coal fields by States, estimates of original and present supply, and the production to the close of 1913—Continued.

	Area.	Estimated original supply.	Production in 1913.	Total production to close of 1913.	Total exhaustion to close of 1913.	Estimated available supply.
BITUMINOUS—continued.						
Interior province—Continued.						
Western and southwestern regions:[a]	*Square miles.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*
Iowa	12,560	29,160,000,000	7,525,936	186,603,097	280,000,000	28,880,000,000
Missouri	23,960	84,000,000,000	4,318,125	120,168,472	180,000,000	83,820,000,000
Kansas	18,600	30,000,000,000	7,202,210	129,696,761	194,500,000	29,805,500,000
Arkansas	7,580	1,887,000,000	2,234,107	36,559,588	55,000,000	1,832,000,000
Oklahoma	10,000	54,951,500,000	4,165,770	59,474,164	89,200,000	54,862,300,000
Texas	68,500	31,000,000,000	2,429,144	26,649,290	40,000,000	30,960,000,000
Total	141,200	230,998,500,000	27,875,292	559,151,372	838,700,000	230,159,800,000
Rocky Mountain and Northern Great Plains provinces.						
Arizona	3,610	14,151,400,000				14,151,400,000
North Dakota	35,980	697,929,400,000	495,320	5,423,516	8,200,000	697,921,200,000
Montana	39,532	381,115,800,000	3,240,973	41,400,059	62,000,000	381,053,800,000
South Dakota	10,980	1,020,300,000				1,020,300,000
Wyoming	41,540	670,723,100,000	7,393,066	118,740,918	178,000,000	670,545,100,000
Utah	11,176	88,345,500,000	3,254,828	34,252,834	51,400,000	88,294,100,000
Colorado	19,754	317,852,600,000	9,232,510	175,361,698	263,000,000	317,589,600,000
New Mexico	14,220	191,840,100,000	3,708,806	41,496,606	62,200,000	191,777,900,000
Idaho	1,230	700,000,000	[b] 2,177	48,623	73,000	699,927,000
Total	178,022	2,363,678,200,000	27,327,680	316,724,254	624,873,000	2,363,053,327,000
Pacific coast province and Alaska.						
Washington	1,800	63,873,100,000	3,877,891	64,459,440	96,700,000	63,776,400,000
Oregon	230	1,000,000,000	46,063	2,165,821	3,250,000	996,750,000
California	40	44,000,000	24,839	5,153,264	7,733,000	36,267,000
Alaska			2,072	47,969		
Total	2,070	64,917,100,000	3,950,865	71,826,494	107,683,000	64,809,417,000
Total production, including colliery consumption	[c] 450,839	3,553,383,400,000	570,048,125	9,844,247,843	15,877,071,700	3,538,506,328,300

[a] Including Arkansas and Texas lignite fields of Gulf province.
[b] Includes a little coal from Nevada.
[c] Includes 89,482 square miles supposed, but not definitely known, to contain usable coal, and 28,470 square miles in which the coal lies under cover 3,000 or more feet in thickness.

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The following statistics cover the annual production of coal in each of the various regions from 1887 to the close of 1913:

Total production of each region, 1887–1913, in short tons.

	Anthracite.	Bituminous.		
		Atlantic coast.	Appalachian.	Northern.
Area[a] ..... square miles..	[b]509	210	69,332	11,000
Year.				
1887	39,548,255	30,000	55,888,088	71,461
1888	43,971,638	33,000	60,966,245	81,407
1889	45,600,487	49,633	62,972,222	67,431
1890	46,468,641	29,608	73,008,102	74,977
1891	50,665,931	37,645	77,984,563	80,307
1892	52,537,467	43,889	83,122,190	77,990
1893	54,061,121	36,878	81,207,168	45,979
1894	51,992,671	68,979	76,278,748	70,002
1895	58,066,516	82,682	90,167,596	112,322
1896	54,425,573	103,483	90,748,305	92,882
1897	52,680,756	116,950	97,128,220	223,592
1898	53,429,739	38,938	114,239,156	315,722
1899	60,514,201	28,353	129,843,906	624,708
1900	57,466,319	57,912	142,298,208	849,475
1901	67,538,536	12,000	150,501,214	1,241,241
1902	41,467,532	39,206	173,274,861	964,718
1903	74,679,799	35,393	185,600,161	1,367,619
1904	73,228,783	9,100	182,606,561	1,342,840
1905	77,734,673	1,557	212,633,324	1,473,211
1906	71,342,659	.....	233,473,524	1,346,338
1907	85,666,404	.....	266,501,527	2,035,858
1908	83,310,412	.....	216,499,163	1,835,019
1909	81,070,359	.....	251,630,500	1,784,602
1910	84,485,236	.....	287,816,446	1,534,967
1911	90,464,067	120	275,212,234	1,476,074
1912	84,361,598	200	307,410,102	1,206,230
1913	91,524,922	.....	330,835,525	1,231,786

	Bituminous.			
	Eastern.	Western and Southwestern.	Rocky Mountain, etc.	Pacific coast and Alaska.
Area[a] ..... square miles..	48,500	141,200	178,022	2,070
Year.				
1887	14,478,883	10,172,634	3,646,280	854,308
1888	19,173,167	11,842,764	4,583,719	1,385,750
1889	16,240,314	10,036,356	5,048,413	1,214,757
1890	20,075,840	10,470,439	6,205,782	1,435,914
1891	20,327,323	11,023,817	7,245,707	1,201,376
1892	23,001,653	11,635,185	7,577,422	1,333,266
1893	25,502,809	11,651,296	8,468,360	1,379,163
1894	22,430,617	11,503,623	7,175,628	1,221,238
1895	23,599,469	11,749,803	7,998,594	1,340,548
1896	25,539,867	11,759,966	7,925,280	1,391,001
1897	26,414,127	13,164,059	8,854,182	1,641,779
1898	25,816,874	13,988,436	10,042,759	2,104,643
1899	33,181,247	15,320,373	11,949,463	2,278,941
1900	35,358,164	17,549,528	13,398,556	2,705,865
1901	37,450,871	19,665,985	14,090,362	2,799,607
1902	46,133,024	20,727,495	16,149,545	2,834,058
1903	52,130,856	23,171,692	16,981,059	3,389,837
1904	51,682,313	23,273,482	16,344,516	3,328,803
1905	55,255,541	23,265,750	19,303,188	3,055,391
1906	59,457,660	23,086,348	22,064,003	3,386,746
1907	71,598,256	26,856,622	23,929,155	3,775,602
1908	65,774,700	23,645,983	21,644,307	3,133,064
1909	71,598,795	25,821,744	25,158,772	3,735,375
1910	72,634,356	22,276,364	28,857,413	3,991,596
1911	75,041,014	24,502,107	26,044,387	3,631,123
1912	83,044,272	26,580,416	28,449,860	3,413,902
1913	87,302,055	27,875,292	27,327,680	3,950,865

[a] Known to contain workable coal. [b] Includes 29 square miles in Colorado and New Mexico.

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The following table shows how the production in the six principal bituminous areas has developed since 1887 and how the percentages of the total produced in each during the last two years compare with one another. The production in the northern region of Michigan shows the largest percentage of increase in the period since 1887, and the percentage of the total contributed by the Pacific coast has decreased:

Production of the six principal bituminous coal regions in 1887, 1912, and 1913, compared, in short tons.

Region.	1887		1912		1913	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.	Quantity.	Percentage of total.
Appalachian	55,888,088	63.11	307,410,102	68.30	330,835,525	69.14
Eastern	14,478,883	16.50	83,044,272	18.45	87,302,055	18.24
Western	10,172,634	11.49	26,580,416	5.90	27,875,292	5.83
Northern	71,461	.08	1,206,230	.27	1,231,786	.26
Rocky Mountain	3,646,280	4.15	28,449,860	6.32	27,327,680	5.71
Pacific coast	854,308	1.00	3,413,902	.76	3,950,865	.82

Region.	Increase in 1913 over 1887.		Increase in 1913 over 1912.	
	Quantity.	Percentage.	Quantity.	Percentage.
Appalachian	274,947,437	491.96	23,425,423	7.62
Eastern	72,823,172	502.96	4,257,783	5.13
Western	17,702,658	174.02	1,294,876	4.87
Northern	1,160,325	1,623.72	25,556	2.12
Rocky Mountain	23,681,400	649.47	a 1,122,180	a 3.94
Pacific coast	3,096,557	362.46	536,963	15.73

a Decrease.

RANK OF COAL-PRODUCING STATES.

In the following table the States are arranged according to their rank as coal producers—first, in the quantity of coal mined, and second, in the value of the product.

In the quantity of coal produced the first nine States held the same relative positions in 1913 as in 1912, but in the value of the product West Virginia, for the first time in its history, outranked Illinois. Kentucky superseded Alabama as fifth in rank of production in 1912 and maintained the lead in 1913, but the latter State remains fifth in the value of the product. Iowa, in 1913, displaced Wyoming in tenth place in the quantity of coal mined, and Kansas displaced the same State in value. Washington went ahead of New Mexico in quantity produced and Utah supplanted Montana. In the value of the product Virginia advanced from fifteenth to thirteenth place, displacing Oklahoma and Missouri, and the last State was also outranked by Tennessee. In the combined production of anthracite and bituminous coal in 1913 Pennsylvania was credited with 46.6 per cent of the total for the United States in quantity, and 51.1 per cent in value, both being slight gains over 1912, when these percentages were, respectively, 46.1 and 50. West Virginia's percentage of the total quantity

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was about the same in 1912, but showed an increase from 9 to 9.5 in the percentage of the total value. Illinois's percentage of the total output decreased from 11.2 in 1912 to 10.8 in 1913, with a decrease in the value from 10.1 to 9.2 per cent. Ohio's percentages in both quantity and value were about the same in both years, as were also those of Alabama. Kentucky's percentage of quantity increased from 3.1 to 3.4, and of value from 2.4 to 2.7.

Rank of coal-producing States in 1912 and 1913, with quantity and value of product and percentage of each.

1912.

Production.				Value.			
Rank.	State.	Quantity (short tons).	Percentage of total production.	Rank.	State.	Value.	Percentage of total value.
1	Pennsylvania:			1	Pennsylvania:		
	Anthracite	84,361,598	15.8		Anthracite	$177,622,026	25.6
	Bituminous	161,865,488	30.3		Bituminous	169,370,497	24.4
2	West Virginia	66,786,687	12.5	2	Illinois	70,294,138	10.1
3	Illinois	59,885,226	11.2	3	West Virginia	62,792,234	9.0
4	Ohio	34,528,727	6.4	4	Ohio	37,083,163	5.3
5	Kentucky	16,490,521	3.1	5	Alabama	20,829,252	3.0
6	Alabama	16,100,600	3.0	6	Indiana	17,480,546	2.5
7	Indiana	15,285,718	2.8	7	Kentucky	16,854,207	2.4
8	Colorado	10,977,824	2.0	8	Colorado	16,345,136	2.4
9	Virginia	7,846,638	1.5	9	Iowa	13,152,088	1.9
10	Wyoming	7,368,124	1.4	10	Wyoming	11,648,088	1.7
11	Iowa	7,289,529	1.4	11	Kansas	11,324,130	1.6
12	Kansas	6,986,182	1.3	12	Washington	8,042,871	1.2
13	Tennessee	6,473,228	1.2	13	Oklahoma	7,867,131	1.1
14	Maryland	4,964,038	.9	14	Missouri	7,633,864	1.1
15	Missouri	4,339,856	.8	15	Virginia	7,518,576	1.1
16	Oklahoma	3,675,418	.7	16	Tennessee	7,379,903	1.1
17	New Mexico	3,536,824	.7	17	Maryland	5,839,079	.8
18	Washington	3,360,932	.6	18	Montana	5,558,195	.8
19	Montana	3,048,495	.6	19	Utah	5,046,451	.7
20	Utah	3,016,149	.6	20	New Mexico	5,037,051	.7
21	Texas	2,188,612	.4	21	Texas	3,655,744	.5
22	Arkansas	2,100,819	.4	22	Arkansas	3,582,789	.5
23	Michigan	1,206,230	.2	23	Michigan	2,399,451	.3
24	North Dakota	499,480	.1	24	North Dakota	765,105	.1
25	Georgia and North Carolina	227,703	.1	25	Georgia and North Carolina	338,926	.1
26	Oregon	41,637		26	Oregon	108,276	
27	California and Alaska	11,333		27	California and Alaska	26,441	
28	Idaho and Nevada	2,964		28	Idaho and Nevada	9,313	
	Total	534,466,580	100.0		Total	695,606,071	100.0

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Rank of coal-producing States in 1912 and 1913, with quantity and value of product and percentage of each—Continued.

1913.

Production.				Value.			
Rank.	State.	Quantity (short tons).	Percentage of total production.	Rank.	State.	Value.	Percentage of total value.
1	Pennsylvania:			1	Pennsylvania:		
	Anthracite	91,524,922	16.1		Anthracite	$195,131,127	25.7
	Bituminous	173,781,217	30.5		Bituminous	193,039,806	25.4
2	West Virginia	71,308,982	12.5	2	West Virginia	71,872,165	9.5
3	Illinois	61,618,744	10.8	3	Illinois	70,313,605	9.2
4	Ohio	36,200,527	6.3	4	Ohio	39,948,058	5.3
5	Kentucky	19,616,600	3.4	5	Alabama	23,083,724	3.0
6	Alabama	17,678,522	3.1	6	Kentucky	20,516,749	2.7
7	Indiana	17,165,671	3.0	7	Indiana	19,001,881	2.5
8	Colorado	9,232,510	1.6	8	Colorado	14,035,090	1.8
9	Virginia	8,828,068	1.5	9	Iowa	13,496,710	1.8
10	Iowa	7,525,936	1.3	10	Kansas	12,036,292	1.6
11	Wyoming	7,393,066	1.3	11	Wyoming	11,510,045	1.5
12	Kansas	7,202,210	1.3	12	Washington	9,243,137	1.2
13	Tennessee	6,903,784	1.2	13	Virginia	8,952,653	1.2
14	Maryland	4,779,839	.8	14	Oklahoma	8,542,748	1.1
15	Missouri	4,318,125	.8	15	Tennessee	7,883,714	1.0
16	Oklahoma	4,165,770	.7	16	Missouri	7,468,308	1.0
17	Washington	3,877,891	.7	17	Maryland	5,927,046	.8
18	New Mexico	3,708,806	.7	18	Montana	5,653,539	.7
19	Utah	3,254,828	.6	19	New Mexico	5,401,260	.7
20	Montana	3,240,973	.6	20	Utah	5,384,127	.7
21	Texas	2,429,144	.4	21	Texas	4,238,920	.6
22	Arkansas	2,234,107	.4	22	Arkansas	3,923,701	.5
23	Michigan	1,231,786	.2	23	Michigan	2,455,227	.3
24	North Dakota	495,320	.1	24	North Dakota	750,652	.1
25	Georgia	255,626	.1	25	Georgia	361,319	.1
26	Oregon	46,063		26	Oregon	116,724	
27	California and Alaska	26,911		27	California and Alaska	95,173	
28	Idaho and Nevada	2,177		28	Idaho and Nevada	5,285	
	Total	570,048,125	100.0		Total	760,488,785	100.0

PRODUCTION BY CLASSES OF MINES.

Since 1909 the chapters on the production of coal have included statements showing the distribution of the output according to the importance of the producing mines in the various States. In these statements the mines have been divided into five classes, those of the first class including the mines producing 200,000 short tons or more during the year; mines of the second class, those producing from 100,000 to 200,000 tons; mines of the third class, those having a production of from 50,000 to 100,000 tons; mines of the fourth class, those producing from 10,000 to 50,000 tons; and mines of the fifth class, those producing less than 10,000 tons. In these compilations only the commercial mines have been considered. No account has been taken of the number or production of country banks operated for purely neighborhood consumption, nor of the anthracite recovered from old culm banks or river beds. Some producers in making their reports to the Geological survey combine the production of two or more mines, if located in the same county, on one schedule; in such cases the production of each mine has been assumed to be the average of all of the mines covered by the schedule.

The statistics for 1913 furnish comparisons of these compilations for a period of five years, and it is interesting to note how, even in this short period of time, the tendency toward concentration of operations into large units has progressed in the bituminous mines. In the anthracite region of Pennsylvania such concentration had

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already been practically accomplished to the limit when the first attempt at this compilation was made, but it is to be observed that even in this highly centralized industry there has been an increase in the number and percentage of the mines of the first class and in the average yearly production by them. In 1909, 55.9 per cent of the anthracite mines were of the first class, and they produced 85.6 per cent of the total production, with an average production of 386,688 short tons by each mine; in 1913 the first class mines represented 62.6 per cent of the total munber, and contributed 89.5 per cent of the total output, with an average per mine of 453,730 short tons. The number and the total production of all the other classes in the anthracite region were less in 1913 than in 1909. The total number of producing mines in the anthracite region has decreased from 304 in 1909 to 278 in 1913, and yet the total production of the commercial mines has increased from 76,813,562 short tons to 88,171,634 tons, and the average production of all mines in the region was 317,164 short tons in 1913, against 252,676 tons in 1912. The average production per mine in the anthracite region is nearly four times the average production of the bituminous mines.

The total number of mines of the first class in the anthracite region in 1913 was 174, an increase of 4 over 1909, but the number of all the other classes of mines has decreased from 134 to 104, indicating clearly that the concentration into larger units in that region has been effected by the closing down of about 25 per cent of the smaller mines and operating the larger properties at greater capacity. In the bituminous regions, with an increase of nearly 100,000,000 tons in the production from commercial mines, there was one more mine in 1913 than in 1909, the total number being 5,775 in the earlier years and 5,776 in the later. The most significant change was in the number and production of the mines of the first class. They were 539 in number in 1909 and 694 in 1913, the increase in the latter year being 155 mines or 29 per cent. The total production from them showed an increase of over 80,000,000 tons, from 160,929,762 tons in 1909 to 241,463,241 tons in 1913, and constituted 80 per cent of the total increase in the five years. The average production per mine increased from 300,426 short tons to 347,930 tons, and the percentage of the total production contributed by them increased from 42.5 to 50.5. The number of mines of the second class increased from 731 to 837, but there has been relatively no change in the average production from mines of this class, the average during the five years ranging between 140,000 and 145,000 tons and the average in 1913 being a little less than in 1909. The same constancy of averages is exhibited in the production of mines of the third, fourth, and fifth classes as in mines of the second class. The number of mines of the third class increased from 915 in 1909 to 960 in 1913, but, although the number of fourth-class mines was larger in 1913 than in 1909, it was less than in either of the three intervening years. The number of mines in the fifth class, which include those producing less than 10,000 tons and which are operated for relatively local trade, has decreased from 2,054 in 1909 to 1,726 in 1913.

In the following table is presented a statement of the number and the percentage of mines of each class, their total and their average production, and the percentage of the total output contributed by each class during the last five years:

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Production of coal in the United States in 1909–1913, according to classes of mines, in short tons.

	First class. (Mines producing over 200,000 tons.)					Second class. (Mines producing from 100,000 to 200,000 tons.)					Third class. (Mines producing from 50,000 to 100,000 tons.)				
	Mines.		Production.			Mines.		Production.			Mines.		Production.		
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.
1909.															
Bituminous	539	9.3	160,929,762	300,426	42.5	731	12.7	104,451,750	142,889	27.6	915	15.8	65,689,994	71,792	17.3
Pennsylvania anthracite	170	55.9	65,736,966	386,688	85.6	50	16.4	8,226,848	164,537	10.7	25	8.2	1,955,821	78,233	2.5
Total	709	11.7	226,666,728	319,699	49.8	781	12.8	112,678,598	144,275	24.7	940	15.5	67,645,815	71,963	14.8
1910.															
Bituminous	618	10.6	191,518,675	309,901	46.0	763	13.1	107,052,053	140,304	25.7	960	16.5	68,858,273	71,727	16.5
Pennsylvania anthracite	157	51.0	65,788,484	419,035	82.5	64	20.8	10,664,819	166,638	13.4	26	8.4	2,281,971	87,768	2.9
Total	775	12.7	257,307,159	332,009	51.9	827	13.5	117,716,872	142,342	23.7	986	16.1	71,140,244	72,150	14.3
1911.															
Bituminous	568	9.6	178,956,538	315,064	44.2	797	13.5	115,072,711	144,382	28.4	853	14.5	60,747,508	71,216	15.0
Pennsylvania anthracite	168	57.5	74,709,145	444,697	87.2	50	17.1	8,514,667	170,293	9.9	21	7.2	1,607,527	76,549	1.9
Total	736	11.9	253,665,683	344,654	51.7	847	13.7	123,587,378	145,912	25.2	874	14.2	62,355,035	71,344	12.8
1912.															
Bituminous	677	11.8	221,017,125	326,465	49.2	790	13.7	112,471,613	142,369	25.0	921	16.0	66,672,953	72,392	14.8
Pennsylvania anthracite	170	61.8	70,000,585	411,768	87.9	46	16.7	7,556,053	164,262	9.4	15	5.6	1,284,301	85,620	1.6
Total	847	14.0	291,017,710	343,586	55.0	836	13.9	120,027,666	143,574	22.6	936	15.5	67,957,254	72,604	12.9
1913.															
Bituminous	694	12.0	241,463,241	347,930	50.5	837	14.5	118,475,544	141,548	24.8	960	16.6	69,073,329	71,951	14.5
Pennsylvania anthracite	174	62.6	78,949,046	453,730	89.5	39	14.0	6,611,711	169,531	7.5	21	7.6	1,832,621	87,268	2.1
Total	868	14.3	320,412,287	369,129	56.6	876	14.5	125,087,255	142,794	22.1	981	16.2	70,905,950	72,279	12.6

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	Fourth class. (Mines producing 10,000 to 50,000 tons.)					Fifth class. (Mines producing less than 10,000 tons.)					Total.		
	Mines.		Production.			Mines.		Production.			Mines.	Quantity.	Average per mine.
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.			
1909.													
Bituminous	1,536	26.6	40,529,922	26,387	10.7	2,054	35.6	7,113,649	3,463	1.9	5,775	378,715,077	65,578
Pennsylvania anthracite	29	9.5	774,172	26,695	1.0	30	10.0	119,755	3,992	.2	304	76,813,562	252,676
Total	1,565	25.7	41,304,094	26,392	9.1	2,084	34.3	7,233,404	3,471	1.6	6,079	455,528,639	74,918
1910.													
Bituminous	1,568	27.0	42,282,021	26,966	10.2	1,909	32.8	6,561,235	3,437	1.6	5,818	416,272,257	71,549
Pennsylvania anthracite	28	9.1	812,517	29,018	1.0	33	10.7	147,808	4,479	.2	308	79,695,509	258,752
Total	1,596	26.0	43,094,538	27,002	8.7	1,942	21.7	6,709,043	3,458	1.4	6,126	495,967,856	80,961
1911.													
Bituminous	1,592	27.1	43,128,432	27,091	10.7	2,077	35.3	6,970,435	3,356	1.7	5,887	404,875,624	68,775
Pennsylvania anthracite	27	9.3	782,856	28,995	.9	26	8.9	111,498	4,288	.1	292	85,725,693	293,581
Total	1,619	26.2	43,911,288	27,122	9.0	2,103	34.0	7,081,933	3,368	1.4	6,179	490,601,317	79,398
1912.													
Bituminous	1,589	27.7	42,839,782	26,960	9.5	1,770	30.8	6,323,650	3,573	1.5	5,747	449,325,123	78,184
Pennsylvania anthracite	24	8.7	668,853	27,869	1.0	20	7.2	90,674	4,534	.1	275	79,600,466	289,456
Total	1,613	26.8	43,508,635	26,974	8.2	1,790	29.8	6,414,324	3,583	1.2	6,022	528,925,589	87,832
1913.													
Bituminous	1,559	27.0	42,335,652	27,156	8.9	1,726	29.9	6,275,111	3,636	1.3	5,776	477,622,877	82,691
Pennsylvania anthracite	21	7.6	683,956	32,569	.8	23	8.2	94,300	4,100	.1	278	88,171,634	317,164
Total	1,580	26.1	43,019,608	27,228	7.6	1,749	28.9	6,369,411	3,642	1.1	6,054	565,794,511	93,458

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In the following tables the statistics of production by classes of mines are given for 1912 and 1913, by States. It will be observed that 84.2 per cent of the anthracite mines are included in the first three classes, that is, those producing 50,000 tons or over, and that less than 1 per cent of the total anthracite product is from mines of the other two classes. Of the bituminous mines, 43 per cent in 1913 were included in the first three classes and they produced 90 per cent of the total output, whereas 57 per cent of the total number was mines of the third and fourth classes, which produced only 10 per cent of the total output.

There were seven States in 1913 in which more than 50 per cent of the total production of bituminous coal was from mines of the first class, but in one of these, Georgia, only two mines were in operation, one of which produced 235,892 tons, or more than 92 per cent of the total for the State. Of the States whose total production exceeded 3,000,000 tons, Utah, a Rocky Mountain State, led with 82 per cent of its total production from mines of the first class, and Montana, another Rocky Mountain State, held the record in both 1912 and 1913 for high average production per mine, three mines in that State having an average output of 555,720 tons in 1912 and 581,597 tons in 1913. Virginia came next to Utah in its percentage of output (71.8) from mines of the first class in 1913 and next to Montana in its high average per mine—453,004 tons. Pennsylvania had 66.7 per cent of its bituminous production in 1913 from mines of the first class, Illinois had 66 per cent, New Mexico 62.6 per cent, and Montana 54 per cent. Three of these States, it will be noted, are in the Rocky Mountain region—public-land States; two are in the Appalachian region, and one in the Central. West Virginia, the second State in the Union in the production of coal, had only 37.6 per cent of its total output from mines of the first class, with 28.9 per cent from those of the second class, and 21.8 per cent from mines of the third class. The tendency toward operation in larger units is exemplified in West Virginia, however, by the increase in the percentage of output from mines of the first class from 23.5 in 1909 to 37.6 in 1913. In 1909 there were 48 first-class mines in West Virginia, and in 1913 there were 89. The total percentage of production of bituminous coal from first-class mines increased from 49.2 in 1912 to 50.5 in 1913. The differences in the percentages from the second-class and third-class mines in the two years were less than one-half of 1 per cent, and the actual total production from each of the fourth-class and fifth-class mines in 1913 was less than in 1912.

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Production of coal in the United States in 1912 and 1913 according to classes of mines, in short tons.

1912.

State.	First class. (Mines producing over 200,000 tons.)					Second class. (Mines producing from 100,000 to 200,000 tons.)					Third class. (Mines producing from 50,000 to 100,000 tons.)				
	Mines.		Production.			Mines.		Production.			Mines.		Production.		
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.
Alabama	13	6.0	3,734,754	287,289	23.2	50	23.0	7,364,764	147,295	45.7	41	18.9	2,967,102	72,368	18.4
Alaska															
Arkansas	1	1.8	279,707	279,707	13.3	6	10.9	784,865	130,811	37.4	7	12.7	506,977	72,425	24.1
California															
Colorado	13	8.2	3,847,332	295,949	35.0	19	12.0	2,610,818	137,411	23.8	39	24.5	2,817,912	72,254	25.7
Georgia						1	50.0	199,219	199,219	87.6					
Idaho															
Illinois	115	20.8	39,027,660	339,371	65.2	88	15.9	12,675,772	144,043	21.2	66	12.0	4,757,036	72,076	7.9
Indiana	18	7.6	4,687,606	260,423	30.6	42	17.6	6,072,590	144,585	39.7	37	15.5	2,839,683	76,748	18.6
Iowa	2	1.0	409,297	204,649	5.6	20	9.1	2,979,009	148,955	40.9	25	11.4	1,823,970	72,959	25.0
Kansas						27	17.6	3,509,287	129,974	50.2	29	19.0	2,168,807	74,786	31.0
Kentucky	8	2.3	2,088,287	261,036	12.8	45	12.8	6,356,977	141,288	38.8	63	17.9	4,207,400	66,784	25.7
Maryland	3	4.0	1,797,599	599,200	36.3	10	13.5	1,393,874	139,387	28.2	10	13.5	810,817	81,082	16.4
Michigan						1	4.5	106,631	106,631	8.8	13	59.1	919,364	70,720	76.2
Missouri	1	.5	228,097	228,097	5.4	11	5.0	1,405,683	127,789	33.1	14	6.5	1,041,607	74,401	24.6
Montana	3	6.1	1,667,159	555,720	54.7	5	10.2	693,870	138,774	22.8	3	6.1	245,918	81,973	8.1
New Mexico	7	20.0	2,546,861	363,837	72.0	4	11.4	631,250	157,813	17.9	2	5.7	149,750	74,875	4.2
North Dakota						1	2.0	181,918	181,918	38.8					
Ohio	58	9.0	16,357,508	282,026	47.8	56	8.7	8,197,305	146,380	23.9	61	9.4	4,584,730	75,160	13.4
Oklahoma						9	8.9	1,130,545	125,616	30.8	17	16.8	1,151,824	67,754	31.4
Oregon															
Pennsylvania bituminous	309	20.9	105,837,953	342,518	65.5	194	13.1	27,871,850	143,669	17.3	221	15.0	16,243,055	73,498	10.0
Tennessee	4	3.4	1,407,606	351,902	21.8	16	13.4	2,159,948	134,997	33.4	21	17.7	1,385,498	65,976	21.4
Texas	1	2.2	230,578	230,578	10.5	7	15.6	737,988	105,427	33.7	10	22.2	664,225	66,423	30.4
Utah	6	26.0	2,385,187	397,531	79.2	3	13.0	420,243	140,081	14.0	2	8.8	133,603	66,802	4.4
Virginia	13	21.3	5,507,875	423,683	70.2	4	6.6	619,211	154,803	7.9	15	24.6	1,103,248	73,550	14.0
Washington	4	8.3	961,210	240,303	28.6	11	22.9	1,516,430	137,857	45.1	6	12.5	417,288	69,548	12.4
West Virginia	84	11.3	24,540,193	292,145	36.8	143	19.3	20,226,111	141,441	30.3	205	27.6	14,603,428	71,236	21.9
Wyoming	14	19.5	3,474,656	248,190	47.2	17	23.6	2,625,365	154,433	35.7	14	19.5	1,129,711	80,694	15.3
Total bituminous	677	11.8	221,017,125	326,465	49.2	790	13.7	112,471,613	142,369	25.0	921	16.0	66,672,953	72,392	14.8
Pennsylvania anthracite	170	61.8	70,000,585	411,768	87.9	46	16.7	7,556,053	164,262	9.4	15	5.6	1,284,301	85,620	1.6
Grand total	847	14.0	291,017,710	343,586	55.0	836	13.9	120,027,666	143,574	22.6	936	15.5	67,957,254	72,604	12.9

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Production of coal in the United States in 1912 and 1913 according to classes of mines, in short tons—Continued.

1912—Continued.

State.	Fourth class. (Mines producing from 10,000 to 50,000 tons.)					Fifth class. (Mines producing less than 10,000 tons.)					Total.		
	Mines.		Production.			Mines.		Production.			Mines.	Quantity.	Average per mine.
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.			
Alabama	75	34.6	1,843,623	24,582	11.5	38	17.5	190,357	5,009	1.2	217	16,100,600	74,196
Alaska						1	100.0	355	355	100.0	1	355	355
Arkansas	20	36.4	453,242	22,662	21.6	21	38.2	76,028	3,620	3.6	55	2,100,819	38,197
California						4	100.0	10,978	2,744	100.0	4	10,978	2,744
Colorado	53	33.3	1,562,581	29,483	14.2	35	22.0	139,181	3,977	1.3	159	10,977,824	69,043
Georgia	1	50.0	28,284	28,284	12.4						2	227,503	113,752
Idaho						3	100.0	2,319	773	100.0	3	2,319	773
Illinois	112	20.3	2,755,551	24,603	4.6	171	31.0	669,207	3,913	1.1	552	59,885,226	108,488
Indiana	48	20.2	1,311,307	27,319	8.6	93	39.1	374,532	4,027	2.5	238	15,285,718	64,226
Iowa	62	28.3	1,641,956	26,483	22.5	110	50.2	435,207	3,956	6.0	219	7,289,529	33,286
Kansas	42	27.5	1,049,202	24,981	15.0	55	35.9	258,886	4,707	3.8	153	6,986,182	45,661
Kentucky	124	35.2	3,341,547	26,948	20.4	112	31.8	377,444	3,370	2.3	352	16,371,655	46,510
Maryland	26	35.2	858,433	23,017	17.4	25	33.8	86,406	3,456	1.7	74	4,947,129	66,853
Michigan	4	18.2	167,169	41,792	13.9	4	18.2	12,855	3,214	1.1	22	1,206,019	54,819
Missouri	46	21.1	1,115,883	24,258	26.3	145	66.9	449,771	3,102	10.6	217	4,241,041	19,544
Montana	11	22.5	361,966	32,906	11.9	27	55.1	76,775	2,844	2.5	49	3,045,688	62,157
New Mexico	7	20.0	169,994	24,285	4.8	15	42.9	38,032	2,535	1.1	35	3,535,887	101,025
North Dakota	10	19.6	176,526	17,653	37.6	40	78.4	110,610	2,765	23.6	51	469,054	9,197
Ohio	160	24.7	4,108,676	25,679	12.0	312	48.2	1,003,909	3,218	2.9	647	34,252,128	52,940
Oklahoma	50	49.5	1,293,069	25,861	35.3	25	24.8	93,069	3,723	2.5	101	3,668,507	36,322
Oregon	2	22.2	25,554	12,777	61.5	7	77.8	16,001	2,286	38.5	9	41,555	4,617
Pennsylvania, bituminous	380	25.7	10,415,567	27,409	6.4	373	25.3	1,347,979	3,614	.8	1,477	161,716,404	109,490
Tennessee	55	46.2	1,422,580	25,865	21.9	23	19.3	95,893	4,169	1.5	119	6,471,525	54,383
Texas	25	55.6	550,661	22,026	25.2	2	4.4	5,160	2,580	2.3	45	2,138,612	48,636
Utah	2	8.8	48,387	24,194	1.6	10	43.4	24,786	2,479	.8	23	3,012,206	130,965
Virginia	23	37.7	603,616	26,244	7.7	6	9.8	11,908	1,984	.2	61	7,845,858	128,621
Washington	12	25.0	389,947	32,496	11.6	15	31.3	76,057	5,070	2.3	48	3,360,932	70,019
West Virginia	235	31.7	7,077,673	30,118	10.6	75	10.1	274,654	3,662	.4	742	66,722,059	89,922
Wyoming	4	5.5	66,788	16,697	.9	23	31.9	65,291	2,839	.9	72	7,361,811	102,247
Total bituminous	1,589	27.7	42,839,782	26,960	9.5	1,770	30.8	6,323,650	3,573	1.5	5,747	449,325,123	78,184
Pennsylvania, anthracite	24	8.7	668,853	27,869	1.0	20	7.2	90,674	4,534	.1	275	79,600,466	289,456
Grand total	1,613	26.8	43,508,635	26,974	8.2	1,790	29.8	6,414,324	3,583	1.2	6,022	528,925,589	87,832

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State	First class. (Mines producing over 200,000 tons.)					Second class. (Mines producing from 100,000 to 200,000 tons.)					Third class. (Mines producing from 50,000 to 100,000 tons.)				
	Mines.		Production.			Mines.		Production.			Mines.		Production.		
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.
Alabama	19	8.5	6,112,051	321,687	34.6	42	18.7	5,862,478	139,583	33.2	44	19.6	3,121,545	70,944	17.6
Alaska															
Arkansas	1	1.9	242,134	242,134	10.8	3	5.7	392,314	130,771	17.6	15	28.3	1,073,798	71,587	48.1
California															
Colorado	7	4.1	2,097,317	299,617	22.7	21	12.3	2,941,436	140,068	31.9	33	19.3	2,422,162	73,399	26.3
Georgia	1	50.0	235,892	235,892	92.3										
Idaho and Nevada															
Illinois	107	20.3	40,655,172	379,955	66.0	93	17.7	13,411,198	144,206	21.8	62	11.8	4,462,182	71,971	7.3
Indiana	28	12.1	8,078,659	288,524	47.2	38	16.5	5,445,416	143,300	31.9	28	12.1	1,902,734	67,955	11.1
Iowa	6	3.0	1,498,626	249,771	20.0	18	8.9	2,556,474	142,026	34.1	23	11.3	1,614,686	70,203	21.5
Kansas						29	19.1	3,693,794	127,372	51.4	42	27.6	2,439,049	58,073	34.0
Kentucky	10	3.0	3,488,229	348,823	17.9	51	15.4	7,244,988	142,059	37.2	80	24.2	5,596,564	69,957	28.7
Maryland	5	7.5	2,165,695	433,139	45.4	5	7.5	752,000	150,400	15.8	14	20.9	1,130,068	80,719	23.7
Michigan						2	7.7	213,626	106,813	17.3	12	46.1	807,028	67,252	65.6
Missouri						12	5.8	1,531,063	127,588	36.2	15	7.2	1,132,721	75,515	26.8
Montana	3	7.0	1,744,790	581,597	54.0	7	16.3	983,401	140,486	30.4	3	7.0	187,580	62,527	5.8
New Mexico	6	16.7	2,322,024	387,004	62.6	6	16.7	1,044,073	174,012	28.2	1	2.7	96,392	96,392	2.6
North Dakota						1	1.8	188,691	188,691	39.5					
Ohio	56	8.4	16,294,149	290,967	45.3	70	10.5	10,523,196	150,331	29.3	63	9.4	4,727,287	75,036	13.1
Oklahoma	1	1.1	202,404	202,404	4.9	9	9.5	1,204,629	133,848	28.9	22	23.1	1,586,964	72,135	38.1
Oregon															
Pennsylvania, bituminous	316	21.0	115,861,271	366,650	66.7	209	13.9	29,297,912	140,181	16.9	225	15.0	16,809,008	74,707	9.7
Tennessee	5	3.7	1,305,260	261,052	18.9	14	10.5	1,911,575	136,541	27.7	29	21.6	1,824,108	62,900	26.5
Texas	1	2.1	222,430	222,430	9.2	9	19.2	950,675	105,631	39.1	8	17.0	541,021	67,628	22.3
Utah	7	25.9	2,667,421	381,060	82.0	2	7.4	317,823	158,912	9.8	3	11.1	207,831	69,277	6.4
Virginia	14	23.3	6,342,058	453,004	71.8	7	11.7	945,216	135,031	10.7	10	16.7	808,086	80,809	9.2
Washington	4	7.6	1,059,956	264,989	27.3	13	24.5	1,803,775	138,752	46.5	9	17.0	596,115	66,235	15.4
West Virginia	89	11.3	26,770,693	300,794	37.6	147	18.7	20,610,855	140,210	28.9	213	27.0	15,505,422	72,795	21.8
Wyoming	8	13.1	2,097,010	262,126	28.4	29	47.5	4,648,937	160,308	62.9	6	9.8	480,978	80,163	6.5
Total bituminous	694	12.0	241,463,241	347,930	50.5	837	14.5	118,475,544	141,548	24.8	960	16.6	69,073,329	71,951	14.5
Pennsylvania, anthracite	174	62.6	78,949,046	453,730	89.5	39	14.0	6,611,711	169,531	7.5	21	7.6	1,832,621	87,268	2.1
Grand total	868	14.3	320,412,287	369,139	56.6	876	14.5	125,087,255	142,794	22.1	981	16.2	70,905,950	72,279	12.6

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Production of coal in the United States in 1912 and 1913 according to classes of mines, in short tons—Continued.

1913—Continued.

State.	Fourth class. (Mines producing from 10,000 to 50,000 tons.)					Fifth class. (Mines producing less than 10,000 tons.)					Total.		
	Mines.		Production.			Mines.		Production.			Mines.	Quantity.	Average per mine.
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.			
Alabama	94	42.0	2,448,122	26,044	13.8	25	11.2	133,496	5,340	0.8	224	17,677,692	78,918
Alaska						1	100.0	2,072	2,072	100.0	1	2,072	2,072
Arkansas	19	35.8	474,753	24,987	21.2	15	28.3	50,406	3,360	2.2	53	2,233,405	42,140
California	1	50.0	18,209	18,209	73.3	1	50.0	6,630	6,630	26.7	2	24,839	12,420
Colorado	54	31.6	1,559,566	28,881	16.9	56	32.7	203,680	3,637	2.2	171	9,224,161	53,942
Georgia	1	50.0	19,734	19,734	7.7						2	255,626	127,813
Idaho and Nevada						3	100.0	2,177	726	100.0	3	2,177	726
Illinois	99	18.8	2,467,368	24,923	4.0	165	31.4	551,727	3,344	.9	526	61,547,647	117,011
Indiana	51	22.1	1,390,194	27,259	8.1	86	37.2	287,753	3,346	1.7	231	17,104,756	74,047
Iowa	54	26.6	1,505,924	27,887	20.1	102	50.2	323,034	3,167	4.3	203	7,498,744	36,940
Kansas	29	19.1	800,754	27,612	11.2	52	34.2	243,626	4,685	3.4	152	7,177,223	47,219
Kentucky	103	31.1	2,827,836	27,455	14.5	87	26.3	338,757	3,894	1.7	331	19,496,374	58,901
Maryland	19	28.3	615,900	32,416	12.9	24	35.8	105,687	4,404	2.2	67	4,769,350	71,184
Michigan	6	23.1	191,541	31,924	15.6	6	23.1	18,432	3,072	1.5	26	1,230,626	47,332
Missouri	47	22.6	1,141,065	24,278	26.9	134	64.4	426,299	3,181	10.1	208	4,231,148	20,342
Montana	11	25.5	259,278	23,571	8.0	19	44.2	58,726	3,091	1.8	43	3,233,775	75,204
New Mexico	8	22.2	200,511	25,064	5.4	15	41.7	42,806	2,854	1.2	36	3,705,806	102,939
North Dakota	9	16.4	158,940	17,660	33.2	45	81.8	130,322	2,896	27.3	55	477,953	8,690
Ohio	142	21.3	3,309,223	23,304	9.2	336	50.4	1,106,970	3,300	3.1	667	35,962,825	53,917
Oklahoma	42	44.2	1,104,914	26,307	26.5	21	22.1	64,296	3,061	1.6	95	4,163,207	43,823
Oregon	1	14.3	16,462	16,462	36.2	6	85.7	29,026	4,838	63.8	7	45,488	6,498
Pennsylvania, bituminous	377	25.1	10,126,045	26,860	5.8	376	25.0	1,540,295	4,096	.9	1,503	173,634,531	115,525
Tennessee	63	47.0	1,747,618	27,740	25.3	23	17.2	111,587	4,852	1.6	134	6,900,148	51,494
Texas	24	51.1	683,218	28,467	28.1	5	10.6	31,800	6,360	1.3	47	2,429,144	51,684
Utah	2	7.4	38,757	19,379	1.2	13	48.2	21,212	684	.6	27	3,253,044	120,483
Virginia	22	36.6	694,315	31,560	7.9	7	11.7	36,906	5,272	.4	60	8,826,581	147,110
Washington	13	24.5	364,747	28,057	9.4	14	26.4	53,208	3,807	1.4	53	3,877,891	73,168
West Virginia	264	33.5	8,041,456	30,460	11.3	75	9.5	317,904	4,239	.4	788	71,246,330	90,414
Wyoming	4	6.6	129,202	32,301	1.7	14	23.0	34,187	2,442	.5	61	7,390,314	121,153
Total bituminous	1,559	27.0	42,335,652	27,156	8.9	1,726	29.9	6,275,111	3,636	1.3	5,776	477,622,877	82,691
Pennsylvania, anthracite	21	7.6	683,956	32,569	0.8	23	8.2	94,300	4,100	.1	278	88,171,634	317,164
Grand total	1,580	26.1	43,019,608	27,228	7.6	1,749	28.9	6,369,411	3,642	1.1	6,054	565,794,511	93,458

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KINDS OF COAL PRODUCED IN THE UNITED STATES.

Under the general head of bituminous coal in this series of reports all coal except the anthracite product of Pennsylvania is considered. Strictly speaking, the anthracite production should include small quantities of that grade mined in Colorado and New Mexico. This factor is so relatively insignificant, however, never having amounted to as much as 100,000 tons in one year, that it has seemed best and has been the invariable custom to give Pennsylvania anthracite separate treatment, and the small Rocky Mountain product has been included in the bituminous production. The latter includes also those grades of coal classed as semianthracite, semibituminous, cannel, block, splint, and lignite. In the following tables the production of these varieties of coal in 1912 and 1913 have been compiled according to the replies made by the operators to the inquiries as to the character of the coal produced. Technical exactness is, therefore, not claimed, but it is believed that the quantities stated approximate quite closely the actual production of each variety in each State, and that they are sufficiently correct for practical purposes.

The table for 1913 shows that in addition to the 81,718,680 long tons (91,524,922 short tons) of anthracite produced in Pennsylvania, 35,416 short tons of this grade of coal were mined in Colorado and 34,345 tons in New Mexico. The principal production of semianthracite is from Arkansas, with smaller quantities from Oklahoma, Colorado, and Virginia. The production of Sullivan County, Pa., is included with the anthracite production of that State, though its classification as anthracite is a matter of some contention. This item amounts to about 600,000 short tons annually. West Virginia leads in the production of semibituminous coal, with Pennsylvania second, Maryland third, and Colorado fourth. West Virginia also leads in the production of splint coal, and Kentucky is the only other State credited with any of this product in 1913. Cannel coal was reported from seven States in 1913, Kentucky contributing nearly two-thirds of the total. Kentucky also took first place in the production of block coal in 1913, displacing Indiana. These two States yielded over 90 per cent of the total production of block coal. Wyoming is the principal producer of subbituminous coal ("black lignite"), 60 per cent of the State's total being of that grade, and Colorado ranks second, with Montana third and New Mexico fourth. All of the output of North Dakota and nearly half of that for Texas is lignite or brown coal. Bituminous coal is produced in every State having a production of 100,000 tons or more, with the exception of North Dakota.

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Classification of the coal product of the United States in 1912, by States, in short tons.

State.	Bituminous.	Anthracite.	Semibituminous.	Lignite and subbituminous.	Semianthracite.	Block.	Splint.	Cannel.	Total.
Pennsylvania	158,364,023	84,361,598	3,433,374					68,091	246,227,086
West Virginia	56,627,727		5,050,993			37,750	[a] 4,834,784	[b] 235,433	66,786,687
Illinois	59,861,735					23,491			59,885,226
Ohio	34,456,137		2,497			66,054		4,039	34,528,727
Kentucky	14,889,478		160,293		3,736	41,050	1,221,295	[c] 174,669	16,490,521
Alabama	16,100,600								16,100,600
Indiana	14,817,006					[d] 461,339		7,373	15,285,718
Colorado	6,601,744	52,165	2,128,847	2,195,068					10,977,824
Virginia	7,800,804				45,834				7,846,638
Wyoming	1,024,395		2,821,069	3,522,660					7,368,124
Iowa	7,220,235					60,950		8,344	7,289,529
Kansas	6,975,862				10,320				6,986,182
Tennessee	6,458,028						2,700	12,500	6,473,228
Maryland	1,363,216		3,600,822						4,964,038
Missouri	4,322,116					14,157		3,583	4,339,856
Oklahoma	3,327,632		73,564		274,222				3,675,418
New Mexico	2,768,869	32,411	100,673	634,871					3,536,824
Washington	2,538,694		215,411	606,827					3,360,932
Montana	656,565		1,405,735	986,195					3,048,495
Utah	2,967,762			48,387					3,016,149
Texas	1,141,667		56,240	990,705					2,188,612
Arkansas	1,049,898		8,319		1,042,602				2,100,819
Michigan	1,206,230								1,206,230
North Dakota				499,480					499,480
Georgia, Oregon, California, Idaho, Nevada, Alaska, North Carolina	240,577		15,153	27,907					283,637
Total	412,781,000	84,446,174	19,072,990	9,512,100	1,376,714	704,791	6,058,779	514,032	534,466,580

[a] Includes 157,537 tons of semisplint coal.
[b] Includes 206,585 tons of semicannel coal.
[c] Includes 86,377 tons of semicannel coal.
[d] Includes 32,842 tons of semiblock coal.

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Classification of the coal product of the United States in 1913, by States, in short tons.

State.	Bituminous.	Anthracite.	Semibituminous.	Lignite and subbituminous.	Semianthracite.	Block.	Splint.	Cannel.	Total.
Pennsylvania	169,351,803	91,524,922	4,371,240					58,174	265,306,139
West Virginia	59,252,804		6,888,239				[a] 5,157,636	10,303	71,308,982
Illinois	61,618,744								61,618,744
Ohio	35,320,706		814,833			58,994		5,994	36,200,527
Kentucky	17,937,086		302,623			538,090	662,414	[b] 176,387	19,616,600
Alabama	17,678,522								17,678,522
Indiana	16,716,226					[c] 449,445			17,165,671
Colorado	5,560,571	35,416	1,546,758	1,995,222	94,543				9,232,510
Virginia	8,774,784				53,284				8,828,068
Iowa	7,506,608					13,700		5,628	7,525,936
Wyoming	1,820,556		894,592	4,677,918					7,393,066
Kansas	7,202,210								7,202,210
Tennessee	6,760,154		136,927					6,703	6,903,784
Maryland	1,230,100		3,549,739						4,779,839
Missouri	4,305,611					8,583		3,931	4,318,125
Oklahoma	3,994,881		25,000		145,889				4,165,770
Washington	2,884,408		236,872	756,611					3,877,891
New Mexico	2,849,499	34,345	23,750	801,212					3,708,806
Utah	3,157,011			97,817					3,254,828
Montana	852,635		1,408,094	980,244					3,240,973
Texas	1,247,968			1,181,156					2,429,144
Arkansas	839,547		23,089		1,371,521				2,234,107
Michigan	1,231,786								1,231,786
North Dakota				496,320					496,320
Georgia, Oregon, California, Idaho, Alaska, Nevada	269,052		35,171	26,554					330,777
Total	438,363,292	91,594,683	20,256,877	11,012,054	1,665,237	1,068,812	5,820,050	267,120	570,048,125

[a] Includes 64,500 tons semisplint coal. [b] Includes 86,263 tons of semicannel coal. [c] Includes 63,329 tons of semiblock coal.

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LABOR STATISTICS.

The coal mines of the United States gave employment in 1913 to nearly 750,000 men (747,644), of whom 571,899, or 76.5 per cent, were employed in the bituminous mines and 175,745, or 23.5 per cent, in the anthracite mines of Pennsylvania. The average working time (257 days) made by the anthracite workers and by the whole number of employees (238 days) in 1913 was the largest on record, and the average time made by the bituminous mine workers (232 days) was exceeded in three years only since 1890, namely, in 1899, 1900, and 1907. The bituminous mine workers also established a new record for the average production per man for one year, 837 tons, and the average tonnage per man in the anthracite region, 520 tons, in 1913 was larger than in any preceding year with the exception of 1911. The average tonnage per man per day in the anthracite mines has shown a declining tendency since 1899 and has decreased each year since 1908, this average in 1913 (2.02 tons) being the lowest made since 1892. The average production per man per day in the bituminous fields, on the other hand, has shown an increasing tendency during the 23 years that these statistics have been compiled, though in 1913 there was a slight change in the other direction from 3.68 tons per man in 1912 to 3.61 tons in 1913. The apparent increase in the efficiency of the employees in the bituminous mines has been due, as shown elsewhere in this report, to the steady increase in the use of mining machines and to the increased ratio that machine-mined coal bears to the total bituminous production.

The following table shows the number of men employed in the coal mines of the United States in 1908, 1910, 1911, 1912, and 1913, with the average number of days worked, by States. The statistics of labor in 1909 were collected by the Bureau of the Census, and the inquiries were in such form that the compilations did not give results comparable with the statistics presented in these reports:

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Statistics of labor employed in coal mines of the United States, 1908–1913, by States.

State.	1908		1910		1911		1912		1913	
	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.
Alabama	222	19,197	249	22,210	227	22,707	245	23,613	255	24,552
Arkansas	145	5,337	128	5,568	133	5,657	157	4,536	174	4,652
California	[a] 220	[a] 49	189	19	[a] 265	[a] 60	[a] 184	[a] 52	[a] 302	40
Colorado	212	14,523	236	15,864	207	14,316	227	13,000	229	11,990
Georgia	261	670	265	386	[b] 277	[b] 514	[b] 254	[b] 450	261	500
Idaho	160	24	200	14	[c] 228	[c] 13	[c] 263	[c] 20	[c] 183	12
Illinois	185	68,035	180	72,645	188	76,600	194	78,098	189	79,529
Indiana	174	18,380	229	21,878	182	21,182	182	21,551	190	22,285
Iowa	214	16,021	218	16,666	203	16,599	188	16,370	195	15,757
Kansas	181	13,916	148	12,870	190	11,357	202	11,646	197	12,479
Kentucky	186	16,996	221	20,316	201	21,921	201	24,304	212	26,332
Maryland	220	6,079	270	5,809	243	5,881	259	6,162	248	5,645
Michigan	207	4,247	211	3,575	218	3,323	183	3,113	188	3,306
Missouri	169	8,988	184	9,691	182	10,259	206	9,704	187	10,418
Montana	224	3,146	239	3,837	220	3,866	220	3,440	228	3,630
New Mexico	197	3,448	283	3,585	230	4,007	274	3,928	289	4,329
North Dakota	181	631	207	534	220	640	232	622	221	641
Ohio	161	47,407	203	46,641	179	46,035	201	45,527	206	45,815
Oklahoma	172	8,651	144	8,657	156	8,790	174	8,785	197	9,044
Oregon	249	214	257	153	179	189	239	222	263	208
Pennsylvania bituminous	201	165,961	238	175,403	233	168,199	252	165,144	267	173,196
Tennessee	209	11,512	225	11,930	232	10,708	234	10,309	241	11,263
Texas	254	4,400	234	4,197	226	5,353	230	5,127	253	5,101
Utah	227	2,664	260	3,053	236	3,060	255	3,328	273	4,158
Virginia	200	6,208	241	7,264	261	7,392	251	8,678	280	9,162
Washington	202	5,484	256	6,314	226	6,498	226	5,519	280	5,794
West Virginia	185	56,861	226	68,663	221	66,730	266	68,248	234	74,786
Wyoming	217	6,915	248	7,771	230	7,924	238	8,086	232	8,331
Total bituminous	193	516,264	217	555,533	211	549,775	223	548,632	232	571,899
Pennsylvania anthracite	200	174,174	229	169,497	246	172,585	231	174,030	267	175,745
Grand total	195	690,438	220	725,030	220	722,360	225	722,662	238	747,644

[a] Includes Alaska.

[b] Includes North Carolina.

[c] Includes Nevada.

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An interesting comparison of the productive efficiency of the employees in the anthracite and bituminous mines during a period of 24 years is presented in the following table. It will be observed that in the anthracite mines during the last decade of the nineteenth century there was a notably decreasing tendency in the number of days the workers in the anthracite mines were able to work, until in 1897 and 1898 they barely averaged 50 per cent of the possible working days in the year, excluding Sundays and legal holidays. These figures substantiate the claim made about that time that the anthracite miners were unable to earn a total living wage. The consumption of the prepared sizes of anthracite being almost exclusively for domestic purposes, the production was at a "peak load" during the fall and winter months, with long periods of idleness during the summer. In order to meet the demands of the "peak loads" it was necessary to keep on the rolls a much larger number of men than if steady employment could be given the year round. In 1901 in order to remedy this unsatisfactory condition the operators adopted the plan of allowing discounts from the circular prices for coal bought during the spring and summer, the purpose being to induce consumers to purchase their supplies at that time and to make the cellars of housekeepers the storage places for the next winter's supply of fuel. No more beneficent action has ever had place in the anthracite region of Pennsylvania and its influence was almost immediately effective, though it did not prevent the great strike of the following year, 1902. Beginning with 1903, however, a marked improvement is shown in the working time made by the anthracite miners. From 1892 to 1902, inclusive, the anthracite mine workers did not average as much as 200 days in any one year and the general average for the period was 173 days. Since 1903, on the other hand, the anthracite miners have averaged less than 200 days in only one year, 1906, when there was an extended suspension pending a renewal of the anthracite strike commission's awards, and the general average for the period has been 220 days, 47 days, or 27 per cent, more than the general average for the earlier period. Coincidentally with this presentation should also be considered, however, the average tonnages made by the anthracite workers. It will be noted that as the working time decreased after 1892 the average production per man per day increased, showing a greater intensity of labor on the days the men were able to work, and that the average tonnage per man per year did not vary between wide extremes, 351 tons for a minimum and 433 tons for a maximum, with a general average of 390 tons. In 1901, the year the spring reductions went into effect, the average production per man rose to 464 tons and since 1903 the general average has been 489 tons with a minimum of 439 tons (49 tons more than the general average for the earlier period) and a maximum of 524 tons. Coincidentally again, it will be noted that with the opportunity for working more days in the year the average tonnage per day per man has shown a decided decrease, the low record of 2.02 tons in 1913 being the smallest in 20 years.

The average working time in the bituminous mines has not shown the same rate of increase in the yearly tonnage per employee, but there has been some improvement in the 13 years of the present cen-

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tury over the last decade of the preceding one. From 1891 to 1900 the workers in the bituminous mines averaged 208 days a year, and since 1901 they have averaged 218 days, a gain of 5 per cent. There has, however, been a marked increase in the average production per man both per year and per day. In the closing decade of the last century the average daily production for each employee ranged from 2.57 tons to 3.09 tons with a mean average of 2.89 tons, and the average per year ranged from 486 tons to 713 tons with a mean average of 600 tons. The first of the 13 years of the present century is the only one in which the average production per man per day has fallen below 3 tons. It has ranged from 2.94 tons in that year to 3.68 tons in 1912 and has had a mean average of 3.30 tons, and the average per year has ranged from 637 tons to 837 tons, with a mean average of 720 tons. In other words, since 1901 the average production per man has shown an increase of 0.37 ton per day and of 120 tons per year over the equivalent averages for the 10 years from 1891 to 1900. The highest average production per man per year in the history of bituminous mining and the lowest average per day in the anthracite mines in 20 years were made in 1913. The increased efficiency of the bituminous workers has not been due to any greater intensity of labor, but to the use of machines in undercutting and shearing the coal. In 1891 a little more than 5 per cent of the total bituminous product was machine mined, in 1901 more than 25 per cent, and in 1913 more than 50 per cent.

Production of coal according to number of persons employed, 1890–1913.

Year.	Anthracite.				Bituminous.			
	Men employed.	Days worked.	Average tonnage per man per day.	Average tonnage per man per year.	Men employed.	Days worked.	Average tonnage per man per day.	Average tonnage per man per year.
1890	126,000	200	1.85	369	192,204	226	2.56	579
1891	126,350	203	1.98	401	205,803	223	2.57	573
1892	129,050	198	2.06	407	212,893	219	2.72	596
1893	132,944	197	2.06	406	230,365	204	2.73	557
1894	131,603	190	2.08	395	244,603	171	2.84	486
1895	142,917	196	2.07	406	239,962	194	2.90	563
1896	148,991	174	2.10	365	244,171	192	2.94	564
1897	149,884	150	2.34	351	247,817	196	3.04	596
1898	145,504	152	2.41	367	255,717	211	3.09	651
1899	139,608	173	2.50	433	271,027	234	3.05	713
1900	144,206	166	2.40	398	304,375	234	2.98	697
1901	145,309	196	2.37	464	340,235	225	2.94	664
1902	148,141	116	2.40	279	370,056	230	3.06	703
1903	150,483	206	2.41	496	415,777	225	3.02	680
1904	155,861	200	2.35	469	437,832	202	3.15	637
1905	165,406	215	2.18	470	460,629	211	3.24	684
1906	162,355	195	2.25	439	478,425	213	3.36	717
1907	167,234	220	2.33	512	513,258	234	3.29	769
1908	174,174	200	2.39	478	516,264	193	3.34	644
1910	169,497	229	2.17	498	555,533	217	3.46	751
1911	172,585	246	2.13	524	549,775	211	3.50	738
1912	174,030	231	2.10	485	548,632	223	3.68	820
1913	175,745	257	2.02	520	571,899	232	3.61	837

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In most of the bituminous coal mines of the United States the length of the working day is 8 hours. In 1913 out of a total of 5,324 mines for which the number of hours worked per day were reported, 3,292, or 62 per cent, worked 8 hours; 946, or 18 per cent of the total, worked 9 hours, and 1,086, or 20 per cent of the total, worked 10 hours. The 8-hour mines employed a total of 347,043 men, the 9-hour mines employed a total of 85,267 men, and the 10-hour mines employed 127,887 men. When these figures are compared with those for 1912 it will be observed that there was a decided decrease in the number of mines that worked 10 hours and in the number of men employed therein, whereas there was a decided increase in the number of mines and in the number of men that worked 8 and 9 hours. The decrease in the 10-hour days and the increase in the 9-hour days were due chiefly to changes in West Virginia in which State in 1912 there were 119 mines employing 10,815 men that worked 9 hours and 535 mines employing 50,944 men that worked 10 hours. In 1913 the number of 9-hour mines was increased to 369 with an aggregate of 35,123 men, while the 10-hour mines were reduced to 365 and the number of 10-hour men to 37,094. In Alabama there was a decrease in 9-hour mines and men and an increase in those working 10-hours, and in Kentucky there was a decrease in the 8-hour mines and men and increases in those working 9 and 10 hours. The States in which the 9-hour and 10-hour days prevail are the States of the southern Appalachian region, Maryland, Virginia, West Virginia, Alabama, Kentucky and Tennessee, which are for the most part "open shop" or nonunion, and the 8-hour day prevails in the States where the men are well organized.

It should be remembered, however, that when the length of the working day is stated, reference is made to the number of hours the mines are supposed to have been in operation, and not to the number of hours worked by the miners. In both the anthracite and bituminous fields practically all the coal is mined by contract at an agreed rate per ton or other basis of payment. The miner is an independent contractor and is not obliged to put in a certain number of hours at his working place. The figures in the following table really indicate the number of hours the men were given opportunity to work, and do not mean that all the employees worked 8, 9, or 10 hours, as the case might be.

Since the settlement of the anthracite strike of 1902 the mines in that region have been operated on a 9-hour basis, with the exception of engineers and pumpmen, who work 8 hours, and of the miners, who work by contract.

In the following table is presented a statement of the number of mines and men working 8, 9, and 10 hours in the important bituminous coal-producing States in 1912 and 1913:

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Number of hours to the working day in 1912 and 1913, by States.

1912.

State.	8 hours.		9 hours.		10 hours.		All others.
	Mines.	Men.	Mines.	Men.	Mines.	Men.	Men.
Alabama	11	338	46	4,145	107	13,988	4,192
Arkansas	46	4,196	.....	.....	.....	.....	340
Colorado	61	2,923	5	173	50	4,631	5,273
Illinois	490	75,411	10	67	.....	.....	2,620
Indiana	211	21,220	1	6	5	109	316
Iowa	194	15,806	1	9	1	4	551
Kansas	132	11,186	7	380	.....	.....	80
Kentucky	69	6,087	58	4,901	149	11,815	1,551
Maryland	2	53	4	41	57	6,000	68
Michigan	20	3,107	.....	.....	.....	.....	6
Missouri	172	9,139	5	72	3	17	476
Montana	39	3,435	.....	.....	1	5	.....
New Mexico	2	4	6	140	23	3,777	7
North Dakota	12	59	4	51	23	415	97
Ohio	581	44,180	11	474	1	10	863
Oklahoma	82	8,105	.....	.....	3	120	560
Oregon	5	170	.....	.....	.....	.....	52
Pennsylvania	774	91,928	316	32,935	214	35,322	4,959
Tennessee	5	317	77	5,720	29	3,980	292
Texas	20	2,908	1	40	19	1,789	390
Utah	22	3,326	1	2	.....	.....	.....
Virginia	2	24	3	41	49	8,181	432
Washington	42	5,344	.....	.....	2	50	125
West Virginia	47	4,959	119	10,815	535	50,944	1,530
Wyoming	60	7,807	1	3	.....	.....	226
Total	3,091	321,982	676	60,015	1,271	141,107	25,006

1913.

Alabama	13	420	36	2,496	135	18,185	3,451
Arkansas	53	4,652	.....	.....	.....	.....	.....
Colorado	146	11,175	3	75	5	128	612
Illinois	482	78,137	7	41	1	5	1,346
Indiana	199	21,637	3	42	6	121	435
Iowa	185	15,248	2	16	1	12	481
Kansas	138	12,240	1	5	.....	.....	234
Kentucky	68	5,754	84	7,389	147	12,390	799
Maryland	3	15	5	203	49	5,105	322
Michigan	24	3,305	.....	.....	.....	.....	.....
Missouri	179	10,200	4	79	.....	.....	139
Montana	40	3,416	1	4	.....	.....	210
New Mexico	16	2,335	8	401	10	1,690	8
North Dakota	13	61	5	51	24	472	57
Ohio	604	45,487	8	187	3	32	109
Oklahoma	87	8,725	.....	.....	2	109	210
Oregon	4	157	.....	.....	.....	.....	46
Pennsylvania	849	100,568	312	32,064	242	38,671	893
Tennessee	9	710	78	6,163	35	3,927	463
Texas	19	2,727	8	525	11	1,299	550
Utah	23	4,063	2	95	.....	.....	.....
Virginia	1	32	8	302	49	8,743	85
Washington	52	5,794	.....	.....	.....	.....	.....
West Virginia	29	1,864	369	35,123	365	37,094	705
Wyoming	56	8,321	2	6	1	4	.....
Total	3,202	347,043	946	85,267	1,086	127,887	11,150

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There are so many influences affecting the mining of bituminous coal that it is difficult, if not impossible, to draw any reliable conclusions in regard to the effect which the length of the working day has upon the productive efficiency of the labor employed. Chief among these influences is the independent character of the miner himself, who being a contractor working "by the job" rarely works the number of hours the mine itself is in operation. The thickness of the bed and the physical character of the coal itself are potential influences upon the capacity of the miner and these vary over such wide ranges, even in one State, that any deductions drawn from the statistics presented herewith may be misleading. The following table shows the prevailing number of hours to the working day in the more important coal-producing States, the number of days worked in each, and the average tonnage made by each employee per day for the years 1912 and 1913. The largest average yearly tonnage per man during 1913 was made in the bituminous mines of Pennsylvania, most of which were operated 8 hours a day. The bituminous mines of Pennsylvania in 1913 established a new record for the average quantity of coal produced per employee which exceeded for the first time in history 1,000 tons per man. The next largest average made in 1913 was in Virginia where the average number of tons per man for the year was 964, followed closely by West Virginia with an average of 954 tons per man. Most of the mines of importance in Virginia are operated 10 hours a day and in West Virginia they are about equally divided between 9 and 10 hours. From the States of the Appalachian region in which were located the three leading States in average tonnage per man per year, the record for the next three States shifts to the Rocky Mountain region where Montana, at 8 hours a day, shows an average tonnage per man of 893 tons; Wyoming, at 8 hours a day, has an average tonnage of 887; and New Mexico, in which the number of men working 8 hours exceeded the number working 10 hours by about 50 per cent, has an average output per man for the year of 857 tons. The smallest average production per man, 373 tons, in 1913, as in 1912, was made in Michigan, an 8-hour State, and in Missouri, also an 8-hour State, the second smallest production per man, 414 tons, was made. The best average daily production per man, 4.1 tons, in 1913 was in Illinois, and 8-hour State; West Virginia came second, with an average of 4.08 tons; Indiana third, with 4.06 tons; and the smallest average daily production per man, 1.88 tons, was made in Texas, Michigan being next to foot with an average of 1.98 tons per man per day.

In 1913 the mean average number of days worked in the mines operating 8 hours a day was 214, and in the States where the 9 and 10 hour day prevailed the average number of days worked was 245, indicating that in the States where the longer days prevailed the men also worked more days in the year. In 1912, when operations in the organized States wese interrupted by suspensions pending the renewal of the wage contracts, mine workers in the 8-hour States averaged 208 working days and in the other States 245 days.

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Average production per man compared with hours worked per day, and average number of days per year in 1912 and 1913.

State.	1912				1913			
	Number of hours per day.	Days worked.	Average tonnage.		Number of hours per day.	Days worked.	Average tonnage.	
			Per year.	Per day.			Per year.	Per day.
Alabama	9 and 10	245	712	2.91	9 and 10	255	720	2.82
Arkansas	8	157	463	2.95	8	174	480	2.76
Colorado	8 and 10	227	844	3.72	8	229	770	3.36
Illinois	8	194	767	3.95	8	189	775	4.10
Indiana	8	182	706	3.88	8	190	772	4.06
Iowa	8	188	445	2.37	8	195	478	2.45
Kansas	8	202	600	2.97	8	197	577	2.93
Kentucky	8, 9, and 10	201	679	3.38	8, 9, and 10	212	745	3.51
Maryland	10	259	806	3.11	10	248	847	3.42
Michigan	8	183	387	2.11	8	188	373	1.98
Missouri	8	206	447	2.17	8	187	414	2.21
Montana	8	220	886	4.03	8	228	893	3.92
New Mexico	10	274	900	3.28	8 and 10	289	857	2.97
North Dakota	10	232	803	3.46	10	221	773	2.90
Ohio	8	201	758	3.77	8	206	790	3.83
Oklahoma	8	174	418	2.4	8	197	461	2.34
Pennsylvania:								
Anthracite	9	231	485	2.1	9	257	520	2.02
Bituminous	a 8	252	980	3.89	a 8	267	1,009	3.78
Tennessee	9 and 10	234	628	2.68	9 and 10	241	613	2.54
Texas	8 and 10	220	424	1.84	8 and 10	253	476	1.88
Utah	8	285	906	3.18	8	273	783	2.87
Virginia	10	251	904	3.6	10	280	964	3.44
Washington	8	226	609	2.69	8	260	669	2.57
West Virginia	8, 9, and 10	266	979	3.68	9 and 10	234	954	4.08
Wyoming	8	238	917	3.85	8	232	887	3.82

a Represents 60 per cent of employees; the other 40 per cent about evenly divided between 9 and 10 hours.

STRIKES AND SUSPENSIONS.

On account of the fact that the wage agreements in the organized bituminous coal-producing regions were signed in 1912 for a period of two years and in the anthracite region for four years, from April 1 of that year, there was no general shutdown or suspension in 1913, but there were the usual number of local disturbances, most of which were settled without much loss of time. In two States, however, West Virginia and Colorado, there were bitterly contested struggles for the recognition of the union, both of them accompanied by bloodshed and both resulting in the declaration of martial law. In Colorado the warfare got beyond the control of the State, and upon the request of the governor, Federal troops were sent to the scene to restore law and order. The trouble in West Virginia began in August, 1912, in the Paint and Cabin Creek districts of Kanawha County, and was carried well forward into the summer of 1913. The trouble in Colorado began in the latter part of September, 1913, and was carried as far into the current year as the struggle in West Virginia was into 1913. The difficulty in West Virginia was confined to a relatively small area in the State, and although the production of Kanawha County was reduced the deficiency was made up by increased production in other parts of the State. In Colorado the most important producing districts of the State were affected and a decided decrease in the total production resulted. The number of men affected by the strike in Colorado was 7,324 (61 per cent of the total number employed) and they were idle for an average of 75 days,

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or for the entire remainder of the year. In West Virginia 8,800 men (12 per cent of the total number of coal miners in the State) were idle for an average of 43 days. In neither West Virginia nor Colorado, however, were as many men on strike in 1913 as there were from local disturbances in Pennsylvania, Ohio, and Illinois. In the anthracite mines of Pennsylvania petty strikes affected a total of 64,086 (within 10 per cent of all the men on strike in all the bituminous mines of the country), but the average time lost by each man was only 8 days. In the bituminous mines of Pennsylvania 17,244 men were on strike for an average of 16 days; in Illinois 11,861 men were idle for an average of 55 days, the total time lost being over 100,000 working days more than the time lost in Colorado; and in Ohio 10,029 men were idle for an average of 26 days. The total number of men idle in the bituminous mines in 1913 was 71,309 for an average of 36 days, compared with 159,098 men for an average of 35 days in 1912. In the anthracite mines, 151,958 men were idle in 1912 for an average of 45 days. Ten States in 1913 reported no strikes, lockouts, or suspensions. These were Alaska, California, Georgia, Idaho, Nevada, North Dakota, Oregon, Texas, Virginia, and Wyoming.

The statistics of labor troubles in the coal fields of the United States in 1912 and 1913 are presented in the following table. In computing the number of days lost, Sundays have not been included, possible working days only having been considered.

Statistics of labor strikes in the coal mines of the United States in 1912 and 1913.

State.	1912			1913		
	Number of men on strike.	Total days lost.	Average number of days lost per man.	Number of men on strike.	Total days lost.	Average number of days lost per man.
Alabama	384	12,323	32	1,048	27,041	26
Arkansas	403	37,685	94	1,221	32,481	27
Colorado				7,324	552,082	75
Illinois	60,505	2,026,526	33	11,861	655,622	55
Indiana	15,400	795,887	52	2,657	44,143	17
Iowa	8,455	370,449	44	721	13,538	19
Kansas	2,088	13,487	65	3,178	28,936	9
Kentucky	2,759	79,685	29	1,029	18,638	18
Maryland	347	3,228	9	200	400	2
Michigan	2,028	101,424	50	180	1,260	7
Missouri	952	55,022	58	918	31,251	34
Montana	869	8,445	10	1,094	6,682	6
New Mexico				8	1,040	130
North Dakota	10	20	2			
Ohio	27,200	895,777	32	10,029	263,234	26
Oklahoma	860	12,109	14	1,696	135,274	80
Oregon	60	420	7			
Pennsylvania	22,538	538,248	24	17,244	274,296	16
Tennessee	670	20,011	30	857	42,966	50
Texas	238	1,724	7			
Utah				5	1,300	260
Washington	807	31,347	39	1,239	60,145	49
West Virginia	12,165	606,588	50	8,800	377,405	43
Wyoming	360	3,425	10			
Total bituminous	159,098	5,613,830	35	71,309	2,567,734	36
Pennsylvania anthracite	151,958	6,913,475	45	64,086	481,678	8

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A summary of the statistics of strikes in the coal mines of the United States since 1899 is given in the following table:

Summary of labor strikes in the coal mines of the United States, 1899–1913.

Years.	Number of men on strike.	Total working days lost.	Average number of days lost per man.
1899	45,981	2,124,154	46
1900	131,973	4,878,102	37
1901 a	20,508	733,802	35
1902	200,452	16,672,217	83
1903 a	47,481	1,341,031	28
1904	77,661	3,382,830	44
1905	37,542	796,735	21
1906	372,343	19,201,348	51.5
1907 a	32,540	462,392	14
1908 a	145,145	5,449,938	38
1909 a	24,763	723,634	29
1910	218,493	19,250,524	88
1911	41,413	983,737	24
1912	311,056	12,527,305	40
1913	135,396	3,049,412	22.5

a Bituminous mines only.

COAL MINED BY MACHINES.

The substitution of mechanical methods for hand labor in the bituminous coal mines of the United States during the last quarter of a century has been one of the most interesting features connected with that branch of the coal-mining industry. It would have been a physical impossibility to have attained the present enormous production of bituminous coal (nearly half a billion tons in 1913) if it had been necessary to depend upon hand labor alone. The results accomplished by the use of mining machines are threefold: (1) The exacting character of the miners' employment is much ameliorated; (2) the percentage of lump coal is increased, which means a better average price for the total product; and (3) the cost of production is reduced. The first is of a humanitarian character, but the two last which are purely economic have been the chief incentives in the change of mining methods which has made the mining of bituminous coal in the United States during the last 25 years an epoch in the history of the industry. In many cases the installation of mining machinery has been forced upon the operators by the constantly advancing cost of labor and the necessity for keeping mining expenses within the lowest possible limits because of the keen competition and the low selling prices which have existed for many years in the principal coal-producing States. In 1890, the first year that the statistics of labor employed in the coal mines of the United States were collected and when the use of mining machines was just beginning, the average production of bituminous coal per man employed was 579 tons and the total production was 111,302,322 short tons. In 1913 the mine employees averaged only 6 more days in the year, the average production per man was 837 tons and the total production was 478,523,203 short tons, about 4.3 times that of 1890. But in 1913, 242,476,559 tons, or a little more than 50 per cent of the total, were machine-mined, whereas in 1890 probably less than 5,000,000 tons (not 5 per cent of the total) were machine mined. At the same rate of production per man as in 1890, the total output of bituminous

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coal in the United States for 1913 would have been about 331,000,000 tons or about two-thirds of the product actually won. If the bituminous mines had worked full 300 days in 1913 the production would have amounted to over 618,000,000 tons.

The total production of bituminous coal in the United States increased from 450,104,982 short tons in 1912 to 478,523,203 tons in 1913. The quantity of coal undercut or otherwise mined by the use of machines increased from 210,538,822 tons to 242,476,559 tons. The increase in the total production was 28,418,221 tons, or 6.3 per cent, and the increase in the output by the use of machines was 31,937,737 tons, or more than 15 per cent. The increase in the production of machine-mined coal exceeded the increase in the total production by 3,519,516 tons. The percentage of machine-mined coal to the total output has increased each year since the first successful mining machines were installed. In 1903, 10 years prior to the period covered by the present report, the quantity of bituminous coal mined by machinery in the United States represented 27.6 per cent of the total; in 1910 it was 41.7 per cent; in 1911, 43.9 per cent; in 1912, 46.8 per cent; and in 1913, 50.7 per cent.

During the last few years there has been a general complaint of shortage of labor in the bituminous fields, a condition favorable to further advances in mining wages and to the more extended use of mining machinery to offset them. It is to be expected, therefore, that the production of coal by mechanical methods will continue to show proportionate increase until a relatively small quantity will be mined by hand. In addition to the economic and humanitarian results accomplished by the use of machines, another important end is attained. The larger the proportion of coal mined by machines the smaller will be the proportion of coal shot off the solid without having been previously mined or sheared. Any step which mitigates that evil in the mining of bituminous coal is a step in advance, and as shown in the section on mining methods in this report, there was a reduction in the percentage of coal mined by powder. Recent developments in the construction of mining machinery have provided machines which are adapted to beds of any inclination., so that there are now practically no insurmountable physical obstacles to the substitution of machines for hand labor.

The methods of attacking the coal by machinery are of two distinct types. One is that of sawing; the other, of chopping. Three types of machines represent the former method—the chain-breast, the long-wall, and the short-wall. In these machines the coal is attacked by bits attached to an endless chain or to the periphery of a disk, and, as can be readily seen, the action is very similar to that of sawing wood. In the second type of machine the coal is attacked by bits attached to arms actuated reciprocally, as in the action of drilling, except that the work of the drill is not confined to one hole, but is freely changed at the will of the operator. These machines are designated as the pick or puncher, in which the drill is mounted on two wheels and operated on a platform in front of the face of the coal, and as the radialaxe or post-puncher, in which the piston is attached to a post and the drill is radiated in one plane. This latter machine has been developed for use in the steep-pitching beds. A new machine, brought out in 1912, combines the sawing and the

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chopping actions of the other two types. In this machine bits are inserted in the manner of a screw around an arm projecting from the machine. This arm is given both a reciprocating and a revolving motion, so that the coal is attacked by both a chopping and a sawing action. This machine was not actually placed on the market until 1913.

The total number of machines reported in use in the bituminous coal mines of the United States in 1913 was 16,381, an increase of 1,083 over 1912, when the number of machines reported was 15,298. The average number of tons mined by each machine in 1913 was 14,802, against 13,763 in 1912, the average for 1913 being the largest tonnage per machine reported. The best record prior to 1913 was in 1899, when the average production per machine was 14,068 tons. The most popular types of machines now in use are the pick or puncher and the chain-breast, the latter being in somewhat more general use in 1913; in 1912 the larger number of machines used were punchers. Out of the total of 16,381 machines in use in 1913, 6,936, or 42.3 per cent, were chain-breast; 6,327 were punchers; 2,210 were short wall; 791 were long wall; and 117 were of the radialaxe or post-puncher type. The rapid gain of the short-wall machine in popularity is referred to in the report for 1912, and it continued in 1913, the number of this type of machine having increased from 1,371 to 2,210, a gain of 839, or 60 per cent. Pennsylvania, the largest producer of bituminous coal, is also first in the total tonnage mined by machines and in the total number of machines in use. West Virginia, the second State in coal-producing importance, ranks also second in the number of machines in use and in the tonnage won by them; but the credit for the largest percentage of machine-mined coal to the total output belongs indisputably to Ohio, whose output of coal mined by machines in 1913 was 90.2 per cent of the total production. In 1912, 87 per cent of Ohio's production was machine mined. Kentucky ranks second in the percentage of the total product mined by machines with 73.2 per cent in 1913, against 66.4 per cent in 1912. Michigan's percentage of machine-mined coal increased from 52.7 per cent in 1912 to 70 per cent in 1913. West Virginia, Pennsylvania, and Indiana were each credited with more than half of their total production mined by machines in both years, and Illinois had 53 per cent in 1913, compared with 45 in 1912. In 1913 Pennsylvania's production of machine-mined coal was 92,487,438 short tons out of a total of 173,781,217 tons. West Virginia, with a total production of 71,308,982 tons, reported 39,410,264 tons mined by machines; Ohio, with a total production of 36,200,527 tons, reported 32,642,848 tons as mined by machines. Illinois's production of machine-mined coal was 32,630,555 out of a total of 61,618,744 tons; Indiana reported 9,737,425 tons as machine-mined out of a total production of 17,165,671.

The statistics in regard to the coal mined by machines during 1912 and 1913 are shown in the following table, together with the number of machines used in each State, the number of tons mined by machines, the total production of the States in which machines were used, and the percentage of the machine-mined product to the total of those States.

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Bituminous coal mined by machines in the United States, 1912 and 1913, by States.

State.	Number of machines in use.		Number of tons mined by machines.	
	1912	1913	1912	1913
Alabama	353	377	3,742,549	4,124,301
Arkansas	9	27	76,611	251,105
California	1	2	200	1,200
Colorado	304	300	2,552,168	2,311,493
Illinois	1,654	1,845	26,878,049	32,630,555
Indiana	687	732	8,363,759	9,737,425
Iowa	24	28	95,342	120,716
Kansas	11	9	75,816	22,120
Kentucky	1,168	1,263	10,954,648	14,353,583
Maryland	53	13	125,625	82,989
Michigan	126	130	635,560	862,700
Missouri	86	104	898,852	863,946
Montana	69	97	984,905	1,076,641
New Mexico	25	44	285,362	497,070
North Dakota	11	13	168,904	222,227
Ohio	1,547	1,681	30,048,831	32,642,848
Oklahoma	60	103	259,719	670,629
Pennsylvania	6,176	6,301	82,192,042	92,487,438
Tennessee	227	252	1,201,895	1,842,658
Texas	21	24	105,400	100,889
Utah	13	50	114,716	625,475
Virginia	185	187	3,205,504	4,206,988
Washington	56	63	258,089	280,515
West Virginia	2,253	2,541	34,946,394	39,410,264
Wyoming	179	195	2,367,882	3,050,784
Total	15,298	16,381	210,538,822	242,476,559

State.	Total tonnage of States using mining machinery.		Percentage of total product mined by machines.	
	1912	1913	1912	1913
Alabama	16,100,600	17,678,522	23.2	23.3
Arkansas	2,100,819	2,234,107	3.7	11.2
California	10,978	24,839	1.8	4.8
Colorado	10,977,824	9,232,510	23.2	25.0
Illinois	59,885,226	61,618,744	44.9	53.0
Indiana	15,285,718	17,165,671	54.7	56.7
Iowa	7,289,529	7,525,936	1.3	1.6
Kansas	6,986,182	7,202,210	1.1	0.3
Kentucky	16,490,521	19,616,600	66.4	73.2
Maryland	4,964,038	4,779,839	2.5	1.7
Michigan	1,206,230	1,231,786	52.7	70.0
Missouri	4,339,856	4,318,125	20.7	20.0
Montana	3,048,495	3,240,973	32.3	33.2
New Mexico	3,536,824	3,708,806	8.1	13.4
North Dakota	499,480	495,320	33.8	44.9
Ohio	34,528,727	36,200,527	87.0	90.2
Oklahoma	3,675,418	4,165,770	7.1	16.1
Pennsylvania	161,865,488	173,781,217	50.8	53.2
Tennessee	6,473,228	6,903,784	18.6	26.7
Texas	2,188,612	2,429,144	4.8	4.2
Utah	3,016,149	3,254,828	3.8	19.2
Virginia	7,846,638	8,828,068	40.8	47.6
Washington	3,360,932	3,877,891	7.7	7.2
West Virginia	66,786,687	71,308,982	52.3	55.3
Wyoming	7,368,124	7,393,066	32.1	41.3
Total	449,832,323	478,217,265	[a] 46.8	[a] 50.7

[a] Average.

One of the determining factors in the choice of machines for undercutting the coal is the character of the roof, it being impracticable to operate chain-breast machines when the roof is tender and the timbering has to be kept up close to the face. This limitation does not apply to the short-wall or continuous-cutter machines,

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which can be operated in mines where the timbering is within 3 feet, or even less, of the face. Neither of these machines is so well adapted as the punchers for use in mines where "sulphur balls" (nodules of iron pyrites) are prevalent, as the sulphur balls will break or quickly dull the cutting bits, whereas the operator of the puncher can cut around them. The limitations of the chain type of machine (including the continuous cutters) are compensated for, however, by the higher efficiency in the mines where they can be used and by the greater ease with which the wires can be carried through the mines as compared with the air pipes for the punchers. It will be observed in the following table that in Ohio where the machine-mined production represents all but about 10 per cent of the total output, chain-breast machines are largely in the ascendency, there being 1,421 of this type of machines out of the total of 1,681 machines in use in the State during 1913. In Pennsylvania the pick machines far outnumber all others and represent more than 50 per cent of the total number of machines in use. In 1913 out of 6,301 machines in Pennsylvania 3,341 were punchers and 2,086 were chain-breast; and of the other important coal-producing States, punchers have exceeded the other types of machines in Alabama, Colorado, Kentucky, and Tennessee, and chain-breast machines outnumber punchers in Illinois, Indiana, Virginia, and West Virginia. Long-wall machines are most numerous in Missouri, and the radialaxe or post-puncher held almost the entire field in the State of Washington. In the following table are shown the number and kind of machines in use in each State, so far as they were reported to the Survey in 1912 and 1913:

Number and kinds of machines in use in 1912 and 1913, by States.

State.	1912						1913					
	Pick.	Chain breast.	Long wall.	Short wall.	Radial axe or post.	Total.	Pick.	Chain breast.	Long wall.	Short wall.	Radial axe or post.	Total.
Alabama	222	60	12	59	.....	353	249	42	20	66	.....	377
Arkansas	.....	.....	.....	6	3	9	.....	23	.....	4	.....	27
California	.....	.....	.....	.....	1	1	.....	.....	.....	.....	2	2
Colorado	187	33	16	57	11	304	168	35	12	80	5	300
Illinois	847	701	22	81	3	1,654	802	906	55	82	.....	1,845
Indiana	198	348	99	42	.....	687	166	365	105	96	.....	732
Iowa	16	3	3	1	1	24	3	7	8	8	2	28
Kansas	9	.....	2	.....	.....	11	5	1	3	.....	.....	9
Kentucky	611	361	54	136	6	1,168	574	377	98	213	1	1,263
Maryland	41	.....	5	7	.....	53	6	1	5	1	.....	13
Michigan	48	37	.....	41	.....	126	26	38	.....	66	.....	130
Missouri	2	2	78	4	.....	86	7	7	80	10	.....	104
Montana	38	21	.....	8	2	69	53	22	.....	19	3	97
New Mexico	7	4	.....	13	1	25	7	6	1	30	.....	44
North Dakota	.....	11	.....	.....	.....	11	.....	4	.....	9	.....	13
Ohio	77	1,362	2	106	.....	1,547	56	1,421	17	187	.....	1,681
Oklahoma	16	14	4	15	11	60	35	13	.....	45	10	103
Pennsylvania	3,660	2,023	52	439	2	6,176	3,341	2,086	137	736	1	6,301
Tennessee	154	17	15	39	2	227	176	21	4	50	1	252
Texas	18	.....	3	.....	.....	21	20	.....	3	1	.....	24
Utah	5	6	.....	2	.....	13	5	7	.....	38	.....	50
Virginia	5	128	1	51	.....	185	4	106	1	76	.....	187
Washington	.....	.....	.....	.....	56	56	1	.....	.....	1	61	63
West Virginia	604	1,217	175	245	12	2,253	562	1,364	231	365	19	2,541
Wyoming	68	77	2	19	13	179	61	84	11	27	12	195
Total	6,833	6,425	545	1,371	124	15,298	6,327	6,936	791	2,210	117	16,381

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The statistics relating to the use of mining machines were first collected by the Survey for the year 1896. The inquiries at that time covered the number of machines in use and the quantity of coal won by them in 1891, five years before. From the returns to the Survey since 1896, the results of which have been published in detail in the preceding volumes of Mineral Resources of the United States, the following table has been prepared, showing the development in the mechanical mining of bituminous coal since 1891:

Production of coal by machines in the United States since 1891, in short tons.

Year.	Number of machines in use.	Total tonnage won by machines.	Average production for each machine.
1891	545	6,211,732	11,398
1896	1,446	16,424,932	11,373
1897	1,956	22,649,220	11,579
1898	2,622	32,413,144	12,362
1899	3,125	43,963,933	14,068
1900	3,907	52,784,523	13,510
1901	4,341	57,843,335	13,325
1902	5,418	69,611,582	12,848
1903	6,658	77,974,894	11,712
1904	7,663	78,606,997	10,258
1905	9,184	103,396,452	11,258
1906	10,212	118,847,527	11,638
1907	11,144	137,973,701	12,381
1908	11,569	123,183,334	10,648
1909	13,049	142,496,878	10,920
1910	13,254	174,012,293	13,127
1911	13,829	178,158,236	12,854
1912	15,298	210,538,822	13,763
1913	16,381	242,476,559	14,802

It has already been shown in the discussion of the statistics of the labor employed in the coal mines of the United States that there has been in the last 25 years a marked increase in the average production per man in the bituminous coal mines which may be attributed directly to the increase in the use of mining machines. In the following table the quantity and percentage of machine-mined coal in 1912 and 1913 are compared with similar statistics for the year 1900. It will be observed that in practically every State in which the machine-mined tonnage has increased the daily and yearly production per man have also increased, but as shown from the figures for 1912 and 1913 this advance is not exhibited in every State when the figures for those two years only are compared. In Alabama, for instance, the quantity of coal mined by machines increased from 3,742,549 tons in 1912 to 4,124,301 tons in 1913, but the average production per man per day decreased from 2.91 to 2.82 tons. Similarly, in Arkansas the production from machine-mined coal increased from 76,611 to 251,105 tons, but the daily output per man decreased from 2.95 to 2.76. The same condition is noted in Michigan, Montana, New Mexico, North Dakota, Pennsylvania (bituminous coal), Tennessee, Utah, Virginia, Washington, and Wyoming. In fact, in the majority of the States in 1913 the average tonnage per day per man was less than it was in 1912.

In the following table the quantity and percentage of machine-mined production in 1900, 1912, and 1913, by States, are compared with the daily and yearly average production by each employee in the States where mining machines are used:

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Average production per man compared with production by machines in 1900, 1912, and 1913, by States, in short tons.

State.	Average tonnage.						Production by machines.					
	Per year.			Per day.			Total tonnage by machines.			Percentage of machine coal to State total.		
	1900	1912	1913	1900	1912	1913	1900	1912	1913	1900	1912	1913
Alabama	601	712	720	2.34	2.91	2.82	370,150	3,742,549	4,124,301	4.4	23.2	23.3
Arkansas	517	463	480	2.36	2.95	2.76	219,085	76,611	251,105	14.8	3.7	11.2
California	454	211	710	1.47	1.14	2.14	.....	200	1,200	.....	1.8	4.8
Colorado	703	844	770	2.66	3.72	3.36	756,025	2,552,168	2,311,493	14.4	23.2	25.0
Illinois	659	767	775	2.92	3.95	4.10	5,083,594	26,878,049	32,630,555	19.7	44.9	53.0
Indiana	553	706	772	2.78	3.88	4.06	1,774,045	8,363,759	9,737,425	27.4	54.7	56.7
Iowa	448	445	478	1.96	2.37	2.45	132,757	95,342	120,716	2.6	1.3	1.6
Kansas	528	600	577	2.28	2.97	2.93	46,164	75,816	22,120	1.0	1.1	.3
Kentucky	551	679	745	2.43	3.38	3.51	2,339,944	10,954,648	14,353,583	43.9	66.4	73.2
Maryland	757	806	847	3.73	3.11	3.42	138,014	125,625	82,989	3.4	2.5	1.7
Michigan	499	387	373	1.91	2.11	1.98	191,577	635,560	862,700	22.6	52.7	70.0
Missouri	433	447	414	2.02	2.17	2.21	110,036	898,852	863,946	3.1	20.7	20.0
Montana	699	886	893	2.77	4.03	3.92	1,045,115	984,905	1,076,641	62.9	32.3	33.2
New Mexico	638	900	857	2.44	3.28	2.97	112,000	285,362	497,070	8.6	8.1	13.4
North Dakota	398	803	773	2.80	3.46	2.90	33,965	168,904	222,227	26.2	33.8	44.9
Ohio	687	758	790	3.20	3.77	3.83	8,835,743	30,048,831	32,642,848	46.5	87.0	90.2
Oklahoma (Indian Territory)	425	418	461	1.86	2.40	2.34	239,424	259,719	670,629	12.5	7.1	16.1
Pennsylvania, bituminous	861	980	1,009	3.56	3.89	3.78	26,867,053	82,192,042	92,487,438	33.7	50.8	53.2
Tennessee	459	628	613	1.90	2.68	2.54	176,872	1,201,895	1,842,658	4.8	18.6	26.7
Texas	340	424	476	1.38	1.84	1.88	.....	105,400	100,889	.....	4.8	4.2
Utah	877	906	783	3.54	3.18	2.87	.....	114,716	625,475	.....	3.8	19.2
Virginia	659	904	964	2.76	3.60	3.44	231,269	3,205,504	4,206,988	9.7	40.8	47.6
Washington	674	609	669	2.33	2.69	2.57	10,000	258,089	280,515	.4	7.7	7.2
West Virginia	777	979	954	3.36	3.68	4.08	3,418,377	34,946,394	39,410,264	15.1	52.3	55.3
Wyoming	753	917	887	2.83	3.85	3.82	653,314	2,367,882	3,050,784	16.3	32.1	41.3

MINING METHODS.

In the report for 1911 the first attempt was made to present statistics of the quantity of bituminous coal properly mined, either by hand or by machine, and of the quantity and percentage that was shot or blasted without having been previously undercut or sheared. The method practiced in the latter case is characterized as "shooting off the solid," the only preparation for which consists in drilling the holes necessary for the explosive charge. So much has been said by speakers and writers in condemnation of this practice, dangerous as it is to life and property and injurious to the quality of the product, that it would hardly seem necessary to do more than repeat the plea for its prohibition by law or by the inspection authorities of the State, and yet in a few States it has been indirectly encouraged by legislation which compels the payment for mining on the mine-run instead of the screened-coal basis. The latest State to enact this kind of a law is Ohio, but fortunately in that State the danger of increasing the quantity of coal shot off the solid is somewhat lessened by the high percentage of coal mined by machines, more than 90 per cent of the total product in 1913 being machine mined and less than 4 per cent shot off the solid. It will be interesting to note if operations under the new law, made effective in 1914, show any appreciable changes in these proportions.

Shooting off the solid increases the liability to accident in a vocation already extra hazardous by accentuating the danger from explosions of gas and dust and from mine fires; it is injurious to the mining

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property in that the inordinate charges of powder weaken the roofs and pillars and this increases the liability to falls of roof and coal, the most prolific cause of fatal accidents in coal mines; and it is wickedly wasteful in that it materially reduces the quality of the product. The heavy charges of powder necessary to blow down the coal when it has not been previously undercut or sheared result in the production of a much larger proportion of fine coal and render the lump coal so friable that it disintegrates badly in handling and in transportation. This naturally creates dissatisfaction on the part of the consumer who buys lump coal and gets, at best, mine-run.

The principal offenders in the practice of shooting off the solid are those States in which for more reasons than one the contrary condition should prevail, and that is in the States of the Middle West in what is designated as the interior province. In these States the product is a dry, noncoking bituminous coal, of which the slack or fine coal is not available in the manufacture of coke; nor is the fine coal or slack as satisfactory a steam fuel as the screened coal, and like the small sizes of anthracite it is sold at below the cost of production. There is absolutely no excuse or logical argument in favor of a continuance of the practice. Of the total quantity of coal shot off the solid (75,155,707 short tons), 38,253,166 tons, or 50.9 per cent, were produced in 1913 in the States of Arkansas, Illinois, Indiana, Iowa, Missouri, and Oklahoma. An improvement in this respect was recorded in 1913 as compared with 1912, and it is to be hoped that this improvement will continue until the shooting of the coal off the solid shall be reduced to a minimum. Arkansas, which in 1912 was the leader in wrong doing, with 92.2 per cent of its output shot off the solid, reported 79.5 per cent so mined in 1913, and Oklahoma, which was only a little behind Arkansas with 86.4 per cent in 1912, reduced its percentage in 1913 to 80.9 per cent. In Illinois the percentage of coal shot off the solid was reduced from 40.3 in 1912 to 33.2 in 1913, and in Kansas from 83.9 to 80.5. Indiana showed about the same percentage in both years—30.2 in 1912 and 30.1 in 1913. Missouri decreased from 48 in 1912 to 46.8 in 1913. Iowa's percentage of coal shot off the solid has increased in both of the last two years, from 68.4 in 1911 to 69.1 in 1912 and to 72.3 in 1913. The entire production of Georgia in 1913, 96.5 per cent of the production of Idaho, and all of the production in Nevada, were reported as shot off the solid, but in Georgia the fine coal is usable and is used in the manufacture of coke, and in the other two States the combined production is only a little over 2,000 tons. West Virginia stood at the head of the honor roll in both years, with less than 1 per cent out of a total production of over 71,000,000 tons in 1913 shot off the solid. Pennsylvania is a good second to West Virginia, with 2.6 per cent of its bituminous product shot off the solid; Ohio came third, with 3.7 per cent; and Utah fourth, with 4.6 per cent. Three of these it will be noted were the three leading States in the Appalachian region, and two of them, Pennsylvania and West Virginia, held the first and second place in coal-producing importance in the United States. The quantity of machine-mined coal increased from 210,538,822 tons, or 46.8 per cent of the total, in 1912 to 242,476,559 tons, or 50.7 per cent, in 1913. The hand-mined coal increased from 136,650,635 tons in 1912 to 141,555,532 tons in 1913, but the percentage decreased from 30.4 to 29.6. The powder-mined coal de-

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creased from 76,241,575 tons to 75,155,707 tons, a decrease in percentage from 16.9 to 15.7.

The following table shows the quantity and percentage of bituminous coal in the several States mined by hand and by machines, shot off the solid, and mined by unreported methods in 1912 and 1913:

Quantity and percentage of bituminous coal mined by different methods, by States, in short tons.

1912.

State.	Mined by hand.	Percentage.	Shot off the solid.	Percentage.	Mined by machines.	Percentage.	Not reported.	Percentage.	Total production.
Alabama	6,658,732	41.4	5,658,457	35.1	3,742,549	23.2	40,862	0.3	16,100,600
Arkansas	73,556	3.5	1,937,817	92.2	76,611	3.7	12,835	.6	2,100,819
California	7,778	70.9	2,500	22.8	209	1.8	500	4.5	10,978
Colorado	7,076,131	64.5	1,309,544	11.9	2,552,168	23.2	39,961	.4	10,977,824
Georgia	147,815	65	79,688	35					227,503
Illinois	7,675,805	12.8	24,136,940	40.3	26,878,049	44.9	1,194,432	2	59,885,226
Indiana	2,094,397	13.7	4,615,580	30.2	8,363,759	54.7	211,982	1.4	15,285,718
Iowa	1,451,673	19.9	5,034,729	69.1	95,342	1.3	707,785	9.7	7,289,529
Kansas	408,835	5.9	5,864,226	83.9	75,816	1.1	637,305	9.1	6,986,182
Kentucky	2,306,222	14	2,727,399	16.5	10,954,648	66.4	502,252	3.1	16,490,521
Maryland	4,668,104	94	121,130	2.5	125,625	2.5	49,179	1	4,964,038
Michigan	120,637	10	443,222	36.7	635,560	52.7	6,811	.6	1,206,230
Missouri	1,036,994	23.9	2,083,656	48	898,852	20.7	320,354	7.4	4,339,856
Montana	923,698	30.3	1,123,571	36.9	984,905	32.3	16,321	.5	3,048,495
New Mexico	2,642,137	74.7	599,463	16.9	285,362	8.1	9,862	.3	3,536,824
North Dakota	71,103	14.2	181,798	36.4	168,904	33.8	77,675	15.6	499,480
Ohio	2,332,767	6.8	1,341,823	3.9	30,048,831	87	805,306	2.3	34,528,727
Oklahoma	49,212	1.3	3,175,455	86.4	259,719	7.1	191,032	5.2	3,675,418
Pennsylvania	54,545,213	33.7	4,801,784	3	82,192,042	50.8	20,326,444	12.5	161,865,488
Tennessee	2,708,650	41.8	2,127,917	32.9	1,201,895	18.6	434,766	6.7	6,473,228
Texas	1,028,025	47	280,105	12.8	105,400	4.8	775,082	35.4	2,188,612
Utah	2,805,498	93	91,992	3.1	114,716	3.8	3,943	.1	3,016,149
Virginia	898,831	11.5	3,741,533	47.7	3,205,504	40.8	780	.....	7,846,638
Washington	1,991,549	59.3	1,102,998	32.8	258,080	7.7	8,301	.2	3,360,932
West Virginia	31,101,454	46.6	453,315	.7	34,946,304	52.3	285,624	.4	66,786,687
Wyoming	1,810,559	24.6	3,180,067	43.2	2,367,882	32.1	9,616	.1	7,368,124
Other States	15,265	33.8	24,971	55.3	.....	.....	4,920	10.9	45,156
Total	136,650,635	30.4	76,241,575	16.9	210,538,822	46.8	26,673,950	5.9	450,104,982

1913.

Alabama	6,315,787	35.7	7,052,234	39.9	4,124,301	23.3	186,200	1.1	17,678,522
Arkansas	205,112	9.2	1,775,351	79.5	251,105	11.2	2,039	.1	2,234,107
California	.....	.....	23,539	95.2	1,209	4.8	.....	.....	24,839
Colorado	5,502,638	60.6	1,286,393	13.9	2,311,493	25	42,086	.5	9,232,510
Georgia	.....	.....	255,626	100	.....	.....	.....	.....	255,626
Illinois	8,069,361	13.1	20,469,139	33.2	32,630,555	53	449,689	.7	61,618,744
Indiana	1,862,729	10.9	5,175,229	30.1	9,737,425	56.7	390,288	2.3	17,165,671
Iowa	1,523,655	20.2	5,440,437	72.3	120,716	1.6	441,128	5.9	7,525,936
Kansas	1,068,039	14.8	5,796,689	80.5	22,120	.3	315,362	4.4	7,202,210
Kentucky	1,755,461	9	3,092,985	15.7	14,353,583	73.2	414,571	2.1	19,616,600
Maryland	4,373,920	91.5	293,950	6.2	82,989	1.7	28,980	.6	4,779,839
Michigan	2,170	.2	363,856	29.5	862,700	70	2,860	.3	1,231,786
Missouri	1,018,588	23.6	2,021,292	46.8	863,946	20	414,299	9.6	4,318,125
Montana	1,003,726	31	1,143,364	35.3	1,076,641	33.2	17,242	.5	3,240,973
New Mexico	2,548,343	68.7	652,969	17.6	497,070	13.4	10,524	.3	3,708,906
North Dakota	54,231	11.1	130,341	26.3	222,227	44.9	87,821	17.7	495,320
Ohio	1,600,305	4.4	1,323,793	3.7	32,642,848	90.2	633,281	1.7	36,200,527
Oklahoma	92,183	2.2	3,371,218	80.9	670,629	16.1	31,740	.8	4,165,770
Pennsylvania	61,509,942	35.4	4,481,956	2.6	92,487,438	53.2	15,301,881	8.8	173,781,217
Tennessee	2,464,970	35.7	2,555,482	37	1,842,658	26.7	40,674	.6	6,903,784
Texas	1,494,996	61.5	612,132	25.2	100,889	4.2	221,127	9.1	2,429,144
Utah	2,416,947	74.2	150,172	4.6	625,475	19.2	62,534	2	3,254,828
Virginia	1,740,485	19.7	2,879,108	32.6	4,206,988	47.6	1,487	.1	8,828,068
Washington	2,120,357	54.7	1,465,248	37.8	280,515	7.2	11,871	.3	3,877,991
West Virginia	31,079,190	43.6	596,184	.8	39,410,264	55.3	223,344	.3	71,308,982
Wyoming	1,618,996	21.9	2,719,884	36.7	3,050,784	41.3	3,702	.1	7,393,066
Other States	23,001	45.7	26,636	53	.....	.....	675	1.3	50,312
Total	141,555,532	29.6	75,155,707	15.7	242,476,559	50.7	19,335,405	4	478,523,203

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COAL-WASHING OPERATIONS.

Since 1908 the schedules requesting information regarding the production of bituminous coal in the United States have included inquiries regarding the quantity of coal washed at the mines. This is done in order to reduce the impurities, ash and sulphur, and to improve the quality of the product either for the market or for coke making. The larger part of the product so treated is slack used in the manufacture of coke, but in some States, notably in Illinois where the coal is noncoking, the washed product is principally nut coal for domestic use. In 1913 the quantity of bituminous coal sent to the washeries operated in connection with the mines was 25,051,801 short tons, which yielded 22,069,691 tons of cleaned coal and 2,982,110 tons of refuse. In 1912 there were 19,844,517 tons sent to the washeries, and the cleaned product obtained was 17,538,572 tons, with 2,305,945 tons of refuse. In the statement of the total production of coal in the United States the refuse is deducted and only the cleaned coal considered as the marketed product. Alabama leads in the quantity of coal washed, nearly one-half of the total quantity so treated in 1913 being from that State. The total quantity of cleaned coal from the Alabama washeries in 1913 was 7,210,588 short tons, of which 60 per cent was used in the manufacture of coke. Pennsylvania was second in the quantity of coal sent to the washeries, with 5,400,444 tons of cleaned coal obtained in 1913. Practically all of it was used in the manufacture of coke, the reports from the coke operators showing that 5,375,000 tons of washed coal were used in the manufacture of coke. In Illinois 4,190,960 tons were sent to the washeries, and the quantity of washed coal obtained was 3,664,928 short tons. A very small portion of this was used in the retort ovens, mixed with West Virginia coal, but over 99 per cent was sized coal, used principally for household fuel. In the State of Washington 1,643,282 tons were sent to the washeries, and the cleaned coal obtained was 1,343,120 tons, of which about 10 per cent was used in the manufacture of coke and the remainder went into the regular market. The three States of Alabama, Pennsylvania, and Illinois reported about 75 per cent of the total quantity of coal washed at the mines.

In the anthracite region of Pennsylvania considerable quantities of usable coal have for a number of years been recovered from the washeries of old culm banks. This item amounted in 1913 to 2,860,021 long tons, or 3,203,224 short tons, as compared with 4,165,288 long tons, or 4,665,123 short tons in 1912. The quantity of coal recovered by the anthracite washeries is not included in the following table, which shows the quantity of bituminous coal washed at the mines in 1912 and 1913:

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Bituminous coal washed at the mines in 1912 and 1913, with quantity of washed coal and of refuse obtained from it, by States, in short tons.

State.	1912			1913		
	Quantity of coal washed.	Quantity of cleaned coal.	Quantity of refuse.	Quantity of coal washed.	Quantity of cleaned coal.	Quantity of refuse.
Alabama	7,187,211	6,325,946	861,265	8,149,082	7,210,588	938,494
Arkansas	72,753	50,563	22,190	46,346	32,985	13,361
Colorado	116,950	107,174	9,776	328,016	266,281	61,735
Georgia	111,923	87,300	24,623	124,306	82,943	41,363
Illinois	3,522,760	3,070,523	452,237	4,190,960	3,664,928	526,032
Indiana	18,784	17,077	1,707	76,132	65,499	10,633
Iowa				31,711	22,080	9,631
Kansas				48,423	39,343	9,080
Kentucky	164,496	150,626	13,870	183,396	162,880	20,516
Maryland	53,842	53,191	651			
Michigan	128,738	113,623	15,115	166,709	145,840	20,869
Missouri	140,582	101,953	38,629	160,487	118,681	41,806
Montana	666,713	599,104	67,609	601,176	547,674	53,502
New Mexico				587,853	487,473	100,380
Ohio	336,639	305,629	31,010	306,713	269,178	37,535
Oklahoma	143,537	117,018	26,519	17,850	14,307	3,543
Oregon	12,501	10,501	2,000	12,958	9,719	3,239
Pennsylvania	4,819,330	4,326,162	493,168	6,011,172	5,400,444	610,728
Tennessee	449,847	390,994	58,853	707,773	624,426	83,347
Texas	25,599	20,639	4,960	28,701	21,761	6,940
Virginia	60,640	56,925	3,715	47,936	45,638	2,298
Washington	863,643	731,521	132,122	1,643,282	1,343,120	300,162
West Virginia	948,029	902,103	45,926	1,580,819	1,493,903	86,916
Total	19,844,517	17,538,572	2,305,945	25,051,801	22,069,691	2,982,110

VALUES PER TON.

Following the advances in wages granted in both the anthracite and bituminous fields by the agreements of 1912 there was a general advance in prices of coal in the important producing States in 1913, a notable exception being shown in Illinois, where, because of peculiar conditions, values declined. Singularly enough, the number of States in which prices advanced and of those in which they declined were exactly the same—13 each; but as the declines were for the most part in the less important States, the general average for bituminous coal showed an advance in 1913 over 1912 of 3 cents a ton. There were only two years in a period of more than three decades in which the average value per ton for bituminous coal exceeded that of 1913. These were 1880, when the statement of values was largely a matter of estimate, and 1903, when, because of the prolonged strike in the anthracite region in 1902 and of long periods of idleness from the same cause in the organized bituminous States, a practical fuel famine existed and prices were abnormally inflated. The average value per ton for anthracite in 1913 was the highest in the period of 34 years for which statistics are available.

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The following tables show the average value per ton, by States, for the last five years, with the advances and declines in 1913, as compared with 1912, and the general averages for anthracite and bituminous values for 34 years:

Average value per short ton for coal at the mines since 1908, by States and Territories.

State.	1908	1909	1910	1911	1912	1913	Advance (+) or decline (−) in 1913.
Alabama	$1.26	$1.19	$1.26	$1.27	$1.29	$1.31	+$0.02
Arkansas	1.68	1.48	1.56	1.61	1.71	1.76	+ .05
California	[a] 3.19	2.21	[a] 2.74	[a] 2.00	[a] 2.33	[a] 3.54	+ 1.21
Colorado	1.41	1.33	1.42	1.45	1.49	1.52	+ .03
Georgia	1.38	1.41	1.46	[b] 1.49	[b] 1.49	1.41	− .08
Idaho	4.02	4.27	3.92	[c] 2.68	[c] 3.14	[c] 2.43	− .71
Illinois	1.05	1.05	1.14	1.11	1.17	1.14	− .03
Indiana	1.06	1.02	1.13	1.08	1.14	1.11	− .03
Iowa	1.63	1.65	1.75	1.73	1.80	1.79	− .01
Kansas	1.49	1.44	1.61	1.53	1.62	1.67	+ .05
Kentucky	1.01	.94	.99	.99	1.02	1.05	+ .03
Maryland	1.17	1.11	1.12	1.11	1.18	1.24	+ .06
Michigan	1.81	1.79	1.91	1.78	1.99	1.99	.....
Missouri	1.64	1.65	1.79	1.72	1.76	1.73	− .03
Montana	1.96	1.97	1.82	1.79	1.82	1.74	− .08
New Mexico	1.37	1.29	1.39	1.44	1.42	1.46	+ .04
North Dakota	1.63	1.56	1.49	1.43	1.53	1.52	− .01
Ohio	1.06	.99	1.05	1.03	1.07	1.10	+ .03
Oklahoma	2.03	2.00	2.22	2.05	2.14	2.05	− .09
Oregon	2.74	2.69	3.48	2.32	2.60	2.53	− .07
Pennsylvania bituminous	1.01	.94	1.02	1.01	1.05	1.11	+ .06
Tennessee	1.15	1.09	1.11	1.12	1.14	1.14	.....
Texas	1.80	1.72	1.67	1.66	1.67	1.77	+ .10
Utah	1.69	1.66	1.68	1.69	1.67	1.65	− .02
Virginia	.91	.89	.90	.91	.96	1.01	+ .05
Washington	2.21	2.54	2.50	2.29	2.39	2.38	− .01
West Virginia	.95	.86	.92	.90	.94	1.01	+ .07
Wyoming	1.62	1.55	1.55	1.56	1.58	1.56	− .02
Total bituminous	1.12	1.07	1.12	1.11	1.15	1.18	+ .03
Pennsylvania anthracite	1.90	1.84	1.90	1.94	2.11	2.13	+ .02
General average	1.28	1.20	1.25	1.26	1.30	1.33	+ .03

[a] Includes Alaska.
[b] Includes North Carolina.
[c] Includes Nevada.

Average value per short ton of coal in the United States for 34 years.

Year.	Anthracite.	Bituminous.	Year.	Anthracite.	Bituminous.
1880	$1.47	$1.25	1897	$1.51	$0.81
1881	2.01	1.12	1898	1.41	.80
1882	2.01	1.12	1899	1.46	.87
1883	2.01	1.07	1900	1.49	1.04
1884	1.79	.94	1901	1.67	1.05
1885	2.00	1.13	1902	1.84	1.12
1886	1.95	1.05	1903	2.04	1.24
1887	2.01	1.11	1904	1.90	1.10
1888	1.91	1.00	1905	1.83	1.06
1889	1.44	.99	1906	1.85	1.11
1890	1.43	.99	1907	1.91	1.14
1891	1.46	.99	1908	1.90	1.12
1892	1.57	.99	1909	1.84	1.07
1893	1.59	.96	1910	1.90	1.12
1894	1.51	.91	1911	1.94	1.11
1895	1.41	.86	1912	2.11	1.15
1896	1.50	.83	1913	2.13	1.18

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SHIPMENTS BY RAILROADS.

Since 1910 schedules asking for the statements of the production of bituminous coal have included inquiries regarding the names of the railroads carrying the product and the quantity of coal shipped over each route. From the replies received to these inquiries the following tables have been prepared showing the initial shipments over each transportation route during 1912 and 1913. Corresponding statements were contained in the reports for 1911 and 1912. The tables show not only the initial shipments taken by each railroad, but the State in which the coal originated. The quantities reported in these tables do not include the coal delivered from one road to another, and consequently do not represent the total quantity of coal carried by the various transportation routes. They do, however, represent quite accurately the total quantity of coal transported. For instance, the total shipments of bituminous coal in 1913 shown in these tables amounted to 403,161,603 short tons, whereas the total quantity reported as loaded at the mines for shipment was 403,530,711 tons, the difference in the two statements being less than one-tenth of 1 per cent. In 1912 the total quantity of bituminous coal loaded for shipment was 377,000,066 short tons, of which 373,897,332 tons were distributed according to the originating railroad or waterway over which the product was shipped. When the originating line is simply a side line of a few miles in length, operated for the purpose of delivering the coal to a regular carrier and not engaged in regular passenger and transportation business, the shipments are considered as originating on the railroad to which the coal is delivered. These tables having been compiled from the reports of the coal producers as to the railways or waterways over which the product was shipped and not from the transportation companies, some difference might be found in the tables presented in this report and those compiled by the railroad companies, but it is believed that such difference would not be material. All of the shipments over any particular railroad system are grouped together. For instance, the Pennsylvania Railroad includes the Pennsylvania lines west of Pittsburgh, such as the Pittsburgh, Fort Wayne & Chicago, the Pittsburgh, Cincinnati, Chicago & St. Louis, the Terre Haute & Indianapolis, the Vandalia, and other subsidiary lines; the New York Central system includes the Lake Shore & Michigan Southern, the Cleveland, Cincinnati, Chicago & St. Louis (Big Four), the Pittsburgh & Lake Erie, the Chicago, Indiana & Southern, the Cincinnati Northern, and other subsidiary lines; the Baltimore & Ohio system includes the Baltimore & Ohio Southwestern, the Cleveland, Lorain & Wheeling, and the Cincinnati, Hamilton & Dayton; the Chesapeake & Ohio system includes the Chesapeake & Ohio Railroad of Indiana, and the Hocking Valley Railway. The Frisco system in 1912 and previous years included the Chicago & Eastern Illinois Railroad, which originated the larger part of the tonnage of the system. These systems have been separated, however; the Chicago & Eastern Illinois is in the hands of a receiver, and the shipments for 1913 were divided between the Chicago & Eastern Illinois and the Frisco system.

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Fifty per cent of the total railroad shipments is taken by the five transportation systems penetrating the Appalachian coal field. These are the Pennsylvania, the Baltimore & Ohio, the New York Central, the Norfolk & Western, and the Chesapeake & Ohio, although the first three also receive a considerable tonnage (more than 17,000,000 tons in the aggregate in 1913) from the central coal field. All of the shipments of the Norfolk & Western and the Chesapeake & Ohio Railroads are from the Appalachian region. A little more than 20 per cent of the total shipments by railroad originates on the Pennsylvania system and chiefly from the Pennsylvania mines. The total quantity of coal reported as shipped over the Pennsylvania Railroad in 1913 was 79,005,844 short tons out of a total of rail shipments of 392,470,769 tons. In 1912 the total shipments originating on the Pennsylvania Railroad were 72,536,245 short tons. The Baltimore & Ohio system is the second coal-carrying route in importance, with total original shipments in 1913 amounting to 37,288,046 short tons, about 2,500,000 tons less than half the shipments over the Pennsylvania system. West Virginia is the most important State contributing to the Baltimore & Ohio tonnage, the shipments from West Virginia mines over the system in 1913 amounting to 14,533,628 short tons; Pennsylvania mines shipped approximately 11,000,000 tons, and Ohio mines a little over 9,000,000 tons. The New York Central system, third in importance as a coal carrier, originated shipments amounting to 35,666,594 short tons, of which considerably more than one-half, or 19,663,538 tons, were from Pennsylvania mines; Illinois mines shipped about 8,000,000 tons over the New York Central lines in 1913, and the Ohio mines contributed practically 6,000,000 tons. The Norfolk & Western and the Chesapeake & Ohio—fourth and fifth, respectively, in importance as coal carriers—received about 80 per cent of their tonnage from the coal fields in the southern part of West Virginia. The former carried approximately 24,000,000 tons in 1913, of which nearly 20,000,000 tons were from the West Virginia mines, and the Chesapeake & Ohio system transported a little over 22,000,000 tons, of which 16,250,000 tons were from West Virginia territory. In 1911 and 1912 the Frisco system, including the Chicago & Eastern Illinois Railroad, ranked sixth among the coal-carrying roads, but on account of the separation in 1913 the Frisco system dropped to thirteenth place and its former position was taken by the Louisville & Nashville Railroad, whose originating shipments in 1913 amounted to 14,600,000, of which 8,000,000 tons were from Kentucky mines and a little more than 4,000,000 tons from Alabama mines. The Illinois Central system originated approximately 14,000,000 tons, nearly 70 per cent of which was from Illinois mines and the remainder practically from Kentucky. The Burlington route handled 12,700,000 tons, of which 8,500,000 tons were from Illinois mines; and the Chicago & Eastern Illinois handled 11,250,000 tons, of which 6,420,000 tons were from Illinois mines and 4,830,000 tons from Indiana mines. The Southern Railway received 10,400,000 tons, chiefly from Alabama and Tennessee mines. Other systems carrying coal in excess of 5,000,000 tons during 1913 were the Buffalo, Rochester & Pittsburgh, the Wheeling & Lake Erie, the Frisco lines, the Union Pacific, and the Missouri Pacific.

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Shipments of bituminous coal in the United States, by railroads and waterways, in 1912.

Railroad.	State.	Quantity.	Total.
		Short tons.	
Pennsylvania Railroad system	Pennsylvania	57,379,312	72,536,245
	Ohio	8,865,812	
	Indiana	4,135,996	
	Illinois	1,388,752	
	West Virginia	751,007	
	Maryland	15,366	
Baltimore & Ohio system	West Virginia	13,540,289	34,376,015
	Pennsylvania	11,018,685	
	Ohio	7,858,167	
	Illinois	1,627,325	
	Maryland	176,315	
	Indiana	155,234	
New York Central lines	Pennsylvania	18,434,865	30,836,347
	Illinois	5,639,307	
	Ohio	5,123,821	
	Indiana	1,089,733	
	Michigan	548,621	
Chesapeake & Ohio lines	West Virginia	16,280,095	22,353,644
	Ohio	4,218,428	
	Kentucky	1,832,121	
	Virginia	23,000	
Norfolk & Western	West Virginia	18,863,182	21,994,109
	Virginia	2,173,323	
	Kentucky	957,604	
Frisco lines	Illinois	5,796,145	14,494,079
	Indiana	4,062,949	
	Kansas	1,971,985	
	Alabama	1,534,915	
	Arkansas	586,651	
	Oklahoma	288,850	
	Missouri	252,255	
	Colorado	429	
Louisville & Nashville	Kentucky	7,033,623	13,916,894
	Alabama	4,252,556	
	Tennessee	1,547,354	
	Illinois	705,010	
	Virginia	378,351	
Illinois Central	Illinois	8,437,621	12,169,144
	Kentucky	3,252,808	
	Indiana	415,437	
	Alabama	63,278	
Burlington	Illinois	7,597,093	11,737,397
	Wyoming	1,593,023	
	Iowa	1,316,035	
	Missouri	771,370	
	Colorado	440,647	
	Kansas	18,229	
Wabash	Ohio	4,757,556	11,477,818
	Illinois	3,657,373	
	Pennsylvania	2,647,668	
	Missouri	324,360	
	Iowa	90,861	
Southern	Alabama	3,959,228	9,585,748
	Tennessee	1,941,536	
	Virginia	1,260,115	
	Illinois	1,063,358	
	Indiana	788,664	
	Kentucky	572,647	
Buffalo, Rochester & Pittsburgh	Pennsylvania	7,666,759	7,666,759
Union Pacific-Southern Pacific lines	Wyoming	5,262,765	6,067,537
	Colorado	362,972	
	Texas	148,688	
	Washington	136,376	
	Utah	94,276	
	Kansas	31,937	
	Oregon	14,361	
	Missouri	12,414	
	California	3,748	
Missouri Pacific	Illinois	2,633,672	5,673,695
	Kansas	1,362,148	
	Arkansas	868,287	
	Missouri	809,288	
	Colorado	300	
Santa Fe	New Mexico	1,893,712	5,032,994
	Kansas	1,346,481	
	Colorado	960,797	
	Illinois	418,228	
	Missouri	398,813	
	Oklahoma	14,963	
Denver & Rio Grande	Utah	2,434,237	4,786,472
	Colorado	2,352,235	

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Shipments of bituminous coal in the United States, by railroads and waterways, in 1912—Continued.

Railroad.	State.	Quantity.	Total.
		Short tons.	
Western Maryland	West Virginia	2,566,512	3,767,387
	Maryland	1,194,066	
	Pennsylvania	6,809	
Chicago, Milwaukee & St. Paul	Illinois	1,500,851	3,621,235
	Iowa	1,182,735	
	Montana	878,802	
	Washington	48,756	
	North Dakota	10,091	
Cumberland & Pennsylvania	Maryland	3,450,644	3,451,028
	Pennsylvania	384	
Virginian	West Virginia	3,382,375	3,382,375
Northern Pacific	Washington	2,109,818	3,380,163
	Montana	1,112,196	
	North Dakota	158,149	
Missouri, Kansas & Texas	Oklahoma	1,420,444	3,211,491
	Kansas	1,264,123	
	Texas	380,279	
	Missouri	166,645	
Chicago & Alton	Illinois	2,983,874	3,131,073
	Missouri	147,199	
Colorado & Southern Railway lines	Colorado	2,913,777	2,941,277
	Texas	27,500	
Kanawha & Michigan	West Virginia	2,624,269	2,799,886
	Ohio	175,617	
Rock Island lines	Oklahoma	1,025,559	2,732,784
	Iowa	925,990	
	Illinois	344,308	
	Arkansas	217,148	
	Missouri	115,690	
	Texas	48,959	
	Colorado	36,500	
	Kansas	18,630	
Chicago & North Western line	Iowa	1,559,075	2,656,509
	Illinois	959,959	
	Wyoming	137,475	
Bessemer & Lake Erie	Pennsylvania	2,617,053	2,617,053
Chicago, Terre Haute & Southeastern	Indiana	2,364,396	2,364,396
Macoupin County	Illinois	2,284,038	2,284,038
Pittsburgh, Shawmut & Northern	Pennsylvania	2,062,599	2,062,599
Erie	Pennsylvania	1,664,753	1,861,029
	Illinois	106,132	
	Ohio	90,144	
Buffalo & Susquehanna	Pennsylvania	1,529,007	1,529,007
Birmingham Southern	Alabama	1,527,974	1,527,974
Carolina, Clinchfield & Ohio	Virginia	1,385,132	1,385,132
Nashville, Chattanooga & St. Louis	Tennessee	1,320,440	1,339,683
	Alabama	19,243	
Mobile & Ohio	Illinois	802,255	1,311,842
	Alabama	509,587	
Minneapolis & St. Louis	Iowa	617,165	1,212,711
	Illinois	595,546	
Queen & Crescent	Tennessee	756,614	1,130,886
	Kentucky	322,052	
	Alabama	52,220	
Texas & Pacific	Texas	998,886	1,003,947
	Arkansas	5,061	
St. Louis, Troy & Eastern	Illinois	963,823	963,823
Monon	Indiana	924,476	924,476
Great Northern Railway lines	Montana	827,255	873,024
	North Dakota	42,529	
	Washington	3,240	
Colorado & Wyoming	Colorado	865,477	865,477
Litchfield & Madison	Illinois	863,975	863,975
St. Louis & O'Fallon	do	819,569	819,569
Pittsburgh, Chartiers & Youghiogheny	Pennsylvania	815,511	815,511
Interstate	Virginia	797,059	797,059
Central of Georgia	Alabama	637,663	745,798
	Georgia	108,135	
Colorado & Southeastern	Colorado	743,932	743,932
El Paso & Southwestern	New Mexico	726,560	726,560
Huntingdon & Broad Top Mountain	Pennsylvania	707,180	707,180
Kansas City Southern	Kansas	591,931	652,258
	Missouri	60,327	
Columbia & Puget Sound	Washington	610,155	610,155
Coal & Coke	West Virginia	610,092	610,092
Toledo, St. Louis & Western	Illinois	588,048	589,491
	Indiana	1,443	
East St. Louis & Suburban	Illinois	589,202	589,202
Chicago, Peoria & St. Louis Railway of Illinois	do	573,529	573,529
East Broad Top Railroad & Coal Co	Pennsylvania	515,504	515,504
Denver, Northwestern & Pacific	Colorado	512,375	512,375

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Shipments of bituminous coal in the United States, by railroads and waterways, in 1912—Continued.

Railroad.	State.	Quantity.	Total.
		Short tons.	
Missouri & Louisiana	Missouri	510,742	510,742
Elgin, Joliet & Eastern	Illinois	509,104	509,104
Ligonier Valley	Pennsylvania	482,996	482,996
Pere Marquette	Michigan	452,218	452,218
Morgantown & Kingwood	West Virginia	431,188	431,188
International & Great Northern	Texas	426,014	426,014
Chicago Great Northern	Iowa	405,875	425,735
	Missouri	13,517	
	Kansas	6,343	
Midland Valley	Arkansas	310,753	423,218
	Oklahoma	112,465	
Illinois Traction System	Illinois	412,927	412,927
Monongahela	Pennsylvania	384,272	384,272
Union	do	372,696	372,696
Missouri, Oklahoma & Gulf	Oklahoma	339,266	339,266
St. Paul & Kansas City Short Line	Iowa	307,774	307,774
Colorado Midland	Colorado	286,225	286,225
Detroit, Toledo & Ironton	Ohio	285,614	285,614
St. Louis & Belleville Electric	Illinois	266,335	266,335
Rock Island Southern	do	265,814	265,814
Peoria & Pekin Union	do	263,677	263,677
Illinois Southern	do	238,946	238,946
Tennessee Central	Tennessee	226,835	226,835
Kentucky & Tennessee	Kentucky	210,196	210,196
Atlanta, Birmingham & Atlantic	Alabama	204,350	204,350
Quincy, Omaha & Kansas City	Missouri	191,379	191,379
Buffalo Creek & Gauley	West Virginia	154,532	154,532
Minneapolis, St. Paul & Sault Ste. Marie	North Dakota	141,697	141,697
Fort Smith & Western	Oklahoma	138,021	138,021
Marietta, Columbus & Cleveland	Ohio	137,959	137,959
Kanawha & West Virginia	West Virginia	128,269	128,269
Evansville, Suburban & Newburgh	Indiana	105,492	105,492
Louisville, Henderson & St. Louis	Kentucky	101,287	102,709
	Arkansas	1,422	
Pittsburgh & Susquehanna	Pennsylvania	95,467	95,467
Seaboard Air Line	Alabama	81,461	81,461
Western Allegheny	Pennsylvania	76,352	76,352
Oklahoma Central	Oklahoma	73,524	73,524
Fort Dodge, Des Moines & Southern	Iowa	69,895	69,895
Ashland Coal & Iron	Kentucky	65,297	65,297
Puget Sound Electric	Washington	64,551	64,551
Wichita Falls & Southern	Texas	63,928	63,928
Philadelphia & Reading	Pennsylvania	40,537	61,023
	Ohio	20,486	
Central Indiana	Indiana	35,794	35,794
Toledo, Peoria & Western	Illinois	30,000	30,000
Miscellaneous	Alabama	461,281	1,412,052
	Kentucky	403,823	
	Illinois	162,168	
	Michigan	79,480	
	Washington	68,381	
	Colorado	48,649	
	Iowa	39,899	
	Ohio	35,038	
	Indiana	28,705	
	West Virginia	27,560	
	Missouri	20,784	
	Kansas	12,686	
	Virginia	10,732	
	Texas	10,000	
	Oklahoma	2,866	
Total railroad shipments		366,864,936	366,864,936
Monongahela River	Pennsylvania	4,988,074	5,037,656
	West Virginia	49,582	
Kanawha River	do	868,542	868,542
Ohio River	Kentucky	331,340	820,812
	West Virginia	271,391	
	Pennsylvania	164,036	
	Ohio	54,045	
Allegheny River	Pennsylvania	164,036	164,036
Illinois River	Illinois	36,017	36,017
Warrior River	Alabama	10,000	10,000
Various waterways	Illinois	66,598	95,333
	Kentucky	28,735	
Total waterway shipments		7,032,396	7,032,396
Grand total		373,897,332	373,897,332

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Shipments of bituminous coal in the United States, by railroads and waterways, in 1913.

Railroad.	State.	Quantity.	Total.
		Short tons.	
Pennsylvania Railroad system	Pennsylvania	63,000,671	79,005,844
	Ohio	9,405,673	
	Indiana	4,614,203	
	Illinois	1,248.735	
	West Virginia	714,316	
	Maryland	22,246	
Baltimore & Ohio system	West Virginia	14,533,628	37,288,046
	Pennsylvania	10,964,609	
	Ohio	9,108,399	
	Illinois	1,416,393	
	Kentucky	857,093	
	Maryland	224,749	
	Indiana	183,175	
New York Central lines	Pennsylvania	19,663,538	35,666,594
	Illinois	8,054,996	
	Ohio	5,920,608	
	Indiana	1,371,830	
	Michigan	655,622	
Norfolk & Western	West Virginia	19,897,245	23,929,001
	Virginia	2,526,629	
	Kentucky	1,505,127	
Chesapeake & Ohio lines	West Virginia	16,261,479	22,101,495
	Ohio	3,980,034	
	Kentucky	1,859,982	
Louisville & Nashville	....do	8,003,626	14,596,873
	Alabama	4,165,452	
	Tennessee	1,533,175	
	Illinois	608,722	
	Virginia	244,597	
	Indiana	41,301	
Illinois Central	Illinois	9,369,083	13,928,062
	Kentucky	3,857,623	
	Indiana	591,310	
	Alabama	110,046	
Burlington	Illinois	8,513,768	12,693,706
	Wyoming	1,757,640	
	Iowa	1,268,384	
	Missouri	802,702	
	Colorado	346,361	
	Kansas	4,851	
Chicago & Eastern Illinois	Illinois	6,419,637	11,247,352
	Indiana	4,827,715	
Southern	Alabama	4,464,297	10,387,624
	Tennessee	2,284,261	
	Virginia	1,259,051	
	Illinois	1,113,299	
	Indiana	943,505	
	Kentucky	322,611	
Buffalo, Rochester & Pittsburgh	Pennsylvania	8,662,836	8,662,836
Wheeling & Lake Erie	Ohio	4,199,972	7,402,798
	Pennsylvania	3,202,826	
Frisco lines	Kansas	2,442,819	5,856,856
	Alabama	2,037,729	
	Arkansas	736,330	
	Oklahoma	377,248	
	Missouri	262,230	
	Colorado	500	
Union Pacific-Southern Pacific lines	Wyoming	4,736,707	5,666,477
	Colorado	320,803	
	Texas	294,985	
	Washington	165,321	
	Utah	91,447	
	Oregon	23,821	
	Kansas	15,982	
	California	14,864	
	Missouri	2,547	
Missouri Pacific	Illinois	2,775,998	5,574,884
	Kansas	1,182,705	
	Missouri	913,260	
	Arkansas	702,335	
	Colorado	586	
Santa Fe	New Mexico	1,638,802	4,627,137
	Kansas	1,452,546	
	Colorado	693,772	
	Illinois	437,009	
	Missouri	368,138	
	Oklahoma	36,870	
Denver & Rio Grande	Utah	2,435,663	4,460,332
	Colorado	1,905,772	
	Wyoming	112,237	
	New Mexico	6,660	

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Shipments of bituminous coal in the United States, by railroads and waterways, in 1913—Continued.

Railroad.	State.	Quantity.	Total.
		Short tons.	
Western Maryland	West Virginia	2,839,356	3,914,683
	Maryland	1,053,002	
	Pennsylvania	22,325	
Rock Island lines	Iowa	1,410,235	3,896,778
	Oklahoma	1,197,226	
	Illinois	666,829	
	Arkansas	296,826	
	Missouri	185,281	
	Colorado	73,931	
	Texas	61,599	
	Kansas	4,851	
Chicago, Milwaukee & St. Paul	Illinois	1,551,666	3,890,030
	Iowa	1,334,907	
	Montana	928,295	
	Washington	72,710	
	North Dakota	2,452	
Northern Pacific	Washington	2,421,608	3,882,851
	Montana	1,194,245	
	North Dakota	154,761	
	Wyoming	112,237	
Wabash	Illinois	3,255,260	3,708,541
	Missouri	308,081	
	Iowa	126,000	
	Ohio	19,200	
Virginian	West Virginia	3,626,016	3,626,016
Cumberland & Pennsylvania	Maryland	3,366,521	3,366,521
Kanawha & Michigan	West Virginia	3,106,949	3,274,927
	Ohio	167,978	
Bessemer & Lake Erie	Pennsylvania	3,228,287	3,228,287
Missouri, Kansas & Texas	Oklahoma	1,398,868	2,865,353
	Kansas	997,467	
	Texas	314,384	
	Missouri	154,634	
Pittsburg, Shawmut & Northern	Pennsylvania	2,837,196	2,837,196
Colorado & Southern Railway lines	Colorado	2,612,040	2,780,576
	Wyoming	112,236	
	Texas	56,300	
Chicago & North Western line	Iowa	1,402,509	2,692,555
	Illinois	1,151,037	
	Wyoming	139,009	
Chicago & Alton	Illinois	2,554,444	2,663,875
	Missouri	109,431	
Chicago, Terre Haute & Southeastern	Indiana	2,492,248	2,492,248
Birmingham Southern	Alabama	2,185,750	2,185,750
Buffalo & Susquehanna	Pennsylvania	1,785,088	1,785,088
Carolina, Clinchfield & Ohio	Virginia	1,609,429	1,609,429
Erie	Pennsylvania	1,495,400	1,565,547
	Ohio	70,147	
Nashville, Chattanooga & St. Louis	Tennessee	1,289,906	1,302,406
	Alabama	12,500	
Mobile & Ohio	Illinois	838,414	1,295,795
	Alabama	457,381	
Minneapolis & St. Louis	Iowa	629,000	1,131,949
	Illinois	502,949	
Texas & Pacific	Texas	1,023,633	1,023,633
Great Northern Railway lines	Montana	898,508	959,828
	North Dakota	42,424	
	Washington	18,896	
Interstate	Virginia	933,290	933,290
Queen & Crescent	Tennessee	733,343	929,757
	Kentucky	104,836	
	Alabama	91,578	
Kansas City Southern	Kansas	785,691	902,235
	Missouri	70,905	
	Oklahoma	45,639	
Central of Georgia	Alabama	771,111	893,610
	Georgia	122,499	
Huntingdon & Broad Top Mountain	Pennsylvania	877,822	877,822
Pittsburgh, Chartiers & Youghiogheny	....do	852,452	852,452
Monon	Indiana	839,282	839,282
Toledo, St. Louis & Western	Illinois	736,775	791,775
	Indiana	55,000	
St. Louis & O'Fallon	Illinois	790,563	790,563
Litchfield & Madison	....do	785,517	785,517
Coal & Coke	West Virginia	776,898	776,898
St. Louis, Troy & Eastern	Illinois	773,493	773,493
Columbia & Puget Sound	Washington	744,002	744,002
El Paso & Southwestern	New Mexico	724,754	724,754
Chicago & Illinois Midland	Illinois	669,557	669,557
Kanawha, Glen Jean & Eastern	West Virginia	641,876	641,876

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Shipments of bituminous coal in the United States, by railroads and waterways, in 1913—Continued.

Railroad.	State.	Quantity.	Total.
		Short tons.	
Cambria & Indiana	Pennsylvania	641,456	641,456
Ligonier Valley	do	622,084	622,084
Morgantown & Kingwood	West Virginia	551,413	551,413
East St. Louis & Suburban	Illinois	541,477	541,477
Missouri & Louisiana	Missouri	523,571	523,571
Chicago, Peoria & St. Louis Railway of Illinois	Illinois	522,556	522,556
Kentucky & Tennessee	Kentucky	512,088	512,088
Chicago Great Western	Iowa	455,733	470,771
	Missouri	10,187	
	Kansas	4,851	
Missouri, Oklahoma & Gulf	Oklahoma	432,175	432,175
Elgin, Joliet & Eastern	Illinois	431,890	431,890
Pere Marquette	Michigan	410,835	410,835
Midland Valley	Arkansas	300,560	390,984
	Oklahoma	90,424	
Peoria & Pekin Union	Illinois	387,812	387,812
International & Great Northern	Texas	368,112	368,112
Denver & Salt Lake	Colorado	315,235	315,235
East Broad Top Railroad & Coal Co	Pennsylvania	313,471	313,471
St. Louis, Rocky Mountain & Pacific	New Mexico	309,065	309,065
Illinois Traction system	Illinois	290,089	290,089
Union	Pennsylvania	284,447	284,447
Tennessee Central	Tennessee	277,136	277,136
St. Louis & Belleville Electric	Illinois	273,298	273,298
Colorado Midland	Colorado	273,279	273,279
Buffalo Creek & Gauley	West Virginia	271,916	271,916
Detroit, Toledo & Ironton	Ohio	269,325	269,325
Monongahela	Pennsylvania	251,288	251,288
Toledo, Peoria & Western	Illinois	234,315	234,315
Colorado & Wyoming	Colorado	211,666	211,666
Oklahoma Central	Oklahoma	205,719	205,719
Atlanta, Birmingham & Atlantic	Alabama	205,373	205,373
Cumberland	Kentucky	195,452	195,452
Marietta, Columbia & Cleveland	Ohio	193,700	193,700
Peoria Railway Terminal	Illinois	162,220	162,220
Kanawha & West Virginia	West Virginia	158,598	158,598
Pittsburgh & Susquehanna	Pennsylvania	156,851	156,851
Illinois Southern	Illinois	146,374	146,374
Denver and Intermountain	Colorado	142,953	142,953
Minneapolis, St. Paul & Sault Ste. Marie	North Dakota	136,603	136,603
West Virginia Northern	West Virginia	115,558	115,558
Evansville, Suburban & Newburgh	Indiana	108,296	108,296
Rio Grande Southern	Colorado	95,200	95,200
Seaboard Air Line	Alabama	90,468	90,468
St. Louis Southwestern	Texas	89,373	89,373
Fort Dodge, Des Moines & Southern	Iowa	87,438	87,438
Louisville, Henderson & St. Louis	Kentucky	82,476	82,476
Ashland Coal & Iron Co	do	81,704	81,704
Puget Sound Electric	Washington	78,036	78,036
Colorado & Southeastern	Colorado	77,308	77,308
St. Louis, Iron Mountain & Southern	Arkansas	76,689	76,689
Wichita Falls & Southern	Texas	76,223	76,223
Laramie, Hahn's Peak & Pacific	Colorado	61,355	61,355
San Antonio & Aransas Pass	Texas	41,985	41,985
Central Indiana	Indiana	31,644	31,644
Grand Trunk	Michigan	15,792	15,792
San Antonio, Uvalde & Gulf	Texas	14,984	14,984
Miscellaneous	Alabama	432,182	1,157,981
	Pennsylvania	244,808	
	Kentucky	85,842	
	Illinois	72,100	
	Ohio	63,315	
	Oklahoma	55,638	
	West Virginia	48,296	
	Virginia	41,885	
	Michigan	29,741	
	Missouri	26,118	
	Iowa	25,570	
	Washington	19,434	
	Kansas	4,851	
	Arkansas	4,618	
	Texas	2,000	
	Alaska	1,568	
	Nevada	15	
Total railroad shipments		392,470,769	392,470,769
Monongahela River	Pennsylvania	8,528,547	8,592,418
	West Virginia	63,871	

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Shipments of bituminous coal in the United States, by railroads and waterways, in 1913—Continued.

Railroad.	State.	Quantity.	Total.
		Short tons.	
Kanawha River	West Virginia	1,018,019	1,018,019
Ohio River	Kentucky	398,155	803,773
	West Virginia	151,323	
	Pennsylvania	133,081	
	Ohio	96,012	
	Indiana	25,202	
Allegheny River	Pennsylvania	133,081	133,081
Kentucky River	West Virginia	50,291	50,291
Warrior River	Alabama	47,729	47,729
Illinois River	Illinois	27,791	27,791
Various waterways	Kentucky	9,424	17,732
	Oregon	7,761	
	Washington	547	
Total waterway shipments		10,690,834	10,690,834
Grand total		403,161,603	403,161,603

IMPORTS AND EXPORTS.

The following tables have been compiled from official returns to the Bureau of Foreign and Domestic Commerce of the Department of Commerce and show the imports and exports of coal from 1907 to 1912, inclusive. The values given in both cases are considerably higher than the average "spot" rates by which the values of the domestic production have been computed.

The exports consist of anthracite and bituminous coal, the quantity of bituminous being the greater in the last few years. They are made principally by rail over the international bridges and by lake and sea to the Canadian Provinces. Exports are also made by sea to the West Indies, to Central and South America, and elsewhere.

The imports are principally from Australia and British Columbia to San Francisco, from Great Britain to the Atlantic and Pacific coasts, and from Nova Scotia to Atlantic coast points.

The total exports of coal from the United States during 1913 were 22,141,143 long tons (equivalent to 24,798,080 short tons), valued at $67,209,514, compared with 18,148,767 long tons (equivalent to 20,326,619 short tons), valued at $56,242,896 in 1912. Of the exports in 1913, 4,154,386 long tons (4,652,912 short tons), valued at $21,759,850, were anthracite, and 17,986,757 long tons (20,145,168 short tons), valued at $45,449,664, were bituminous coal.

In 1912 the exports of anthracite were 3,688,789 long tons (4,131,443 short tons), and the quantity of bituminous coal exported was 14,459,978 long tons (16,195,175 short tons). The total exports in 1913 exceeded those of 1912 by 3,992,376 long tons (equivalent to 4,471,461 short tons) in quantity, and by $10,966,618 in value. The anthracite exports increased 465,597 long tons (521,469 short tons) in quantity, and $2,334,587 in value. The bituminous exports increased 3,526,779 long tons (3,949,992 short tons) in quantity, and $8,632,031 in value.

The imports of anthracite are unimportant, amounting to only 896 long tons in 1913 and averaging less than 4,000 tons for the last four years. The imports of bituminous coal and shale amounted to 1,412,997 long tons (equivalent to 1,582,557 short tons), valued at $3,853,930, against 1,605,873 long tons (1,798,578 short tons), valued

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at $4,509,066, in 1912. The imports in 1913 included 352,007 long tons (394,248 short tons) of slack or culm passing through a ½-inch screen, having a value of $689,864. This is used for making coke at Everett, near Boston, Mass. Most of the anthracite imported into the United States is to San Francisco and other points on the Pacific coast, and is brought in principally as ballast in vessels coming for outgoing cargoes. Compared with the domestic production, the total quantity of coal imported into the United States is of little consequence. The imports during the last three years have been less than 0.3 per cent of the production.

Coal of domestic production exported from the United States, 1909–1913, in long tons.

Year.	Anthracite.		Bituminous and shale.	
	Quantity.	Value.	Quantity.	Value.
1909	2,842,714	$14,141,468	9,693,843	$24,300,050
1910	3,021,627	14,785,387	10,784,239	26,685,405
1911	3,553,999	18,093,285	13,878,754	34,499,989
1912	3,688,789	19,425,263	14,459,978	36,817,633
1913	4,154,386	21,759,850	17,986,757	45,449,664

Coal imported and entered for consumption in the United States, 1909–1913, in long tons.

Year.	Anthracite.		Bituminous and shale.	
	Quantity.	Value.	Quantity.	Value.
1909	3,191	$12,915	1,274,903	$3,628,533
1910	8,196	42,244	1,986,258	4,761,223
1911	2,463	12,550	1,234,998	3,604,797
1912	1,670	8,329	[a] 1,605,873	4,509,066
1913	896	5,620	[a] 1,412,997	3,853,930

[a] Includes 455,587 long tons of slack or culm (value, $901,051) passing ½-inch screen in 1912 and 352,007 tons (value $689,864) in 1913.

Tariff.—The tariff from 1824 to 1843 was 6 cents per bushel, or $1.68 per long ton; from 1843 to 1846, $1.75 per ton; 1846 to 1857, 30 per cent ad valorem; 1857 to 1861, 24 per cent ad valorem; 1861, bituminous and shale, $1 per ton; all other, 50 cents per ton; 1862 to 1864, bituminous and shale, $1.10 per ton; all other, 60 cents per ton; 1864 to 1872, bituminous and shale, $1.25 per ton; all other, 40 cents per ton. By the act of 1872 the tariff on bituminous coal and shale was made 75 cents per ton, and so continued until the act of August, 1894, changed it to 40 cents per ton. On slack or culm the tariff was made 40 cents per ton by the act of 1872, was changed to 30 cents per ton by the act of March, 1883, and so continued until the act of August, 1894, changed it to 15 cents per ton. The tariff act of 1897 provided that all coals which contain less than 92 per cent fixed carbon and which will pass over a half-inch screen shall pay a duty of 67 cents per ton. Slack or culm was not changed by the act of 1897. Tons are all 2,240 pounds. Anthracite coal has been free of duty since 1870. During the period from June, 1854, to March, 1866, the reciprocity treaty was in force, and coal from the British possessions

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in North America was admitted into the United States duty free. A special act of Congress placed all the coal on the free list for one year from January 1, 1903, in order to relieve the shortage caused by the anthracite strike of 1902. Under the tariff act approved August 5, 1909, anthracite is practically excluded. It remained on the free list, but only as coal stores for American vessels, and could not be unloaded. The rate on bituminous coal was placed at 45 cents per long ton, and the rate on slack or culm was fixed at 15 cents per ton. Under the tariff act of October 3, 1913, all kinds of coal—anthracite, bituminous, culm, slack, and shale, coke and manufactured fuel in the form of briquets—were placed on the free list.

WORLD'S PRODUCTION OF COAL.

Since 1899, when the United States supplanted Great Britain as the leading coal-producing country of the world, this country's relative importance in that respect has steadily advanced. In the 14 years from 1899 to 1913 the coal production of the United States has increased from 253,741,192 short tons to 570,048,125 short tons, a gain of 316,306,933 tons, or nearly 125 per cent. The production in Great Britain during the same period has increased a little over 30 per cent, from 246,506,155 tons to 321,922,130 tons; Germany, which ranks third among the coal-producing countries of the world, has increased its production by a ratio (88 per cent) nearly three times that of Great Britain, from 149,719,766 tons in 1899 to 281,979,467 tons in 1912.[1] The combined production of Great Britain in 1913 and Germany in 1912 was 603,901,597 short tons, which exceeded that of the United States alone by less than 6 per cent. In 1913 the United States in the production of coal exceeded Great Britain by 248,125,995 short tons, or nearly 80 per cent, and Germany's production in 1912 by 288,068,658 tons, or more than 100 per cent.

The total production of all the European countries in 1913 (latest figures available used when statistics for 1913 are not at hand) amounted to about 772,000,000 tons, or about 35 per cent more than that of the United States alone. The total world's production was approximately 1,443,400,000 short tons, of which the United States contributed 39.5 per cent, Great Britain 22 per cent, and Germany 20 per cent. The United States in 1913 increased its production by over 35,000,000 tons, and Great Britain by 30,000,000 tons. In 1912 Germany came within 10,000,000 tons, or 3 per cent, of equaling Great Britain, but in 1913 Great Britain exceeded Germany's production in 1912 by nearly 40,000,000 tons.

The writer is indebted for the figures covering the production of coal in foreign countries, as shown in the following table, to Mr. William G. Gray, statistician of the American Iron and Steel Institute. Where the statistics for 1913 are not available, those for the year nearest 1913 for which they could be obtained are given. For the sake of convenience the quantities are expressed in the measurement customary in each country and are reduced for purposes of comparison to the short ton of 2,000 pounds.

[1] The statistics of Germany's production in 1913 are not available as this report goes to press.

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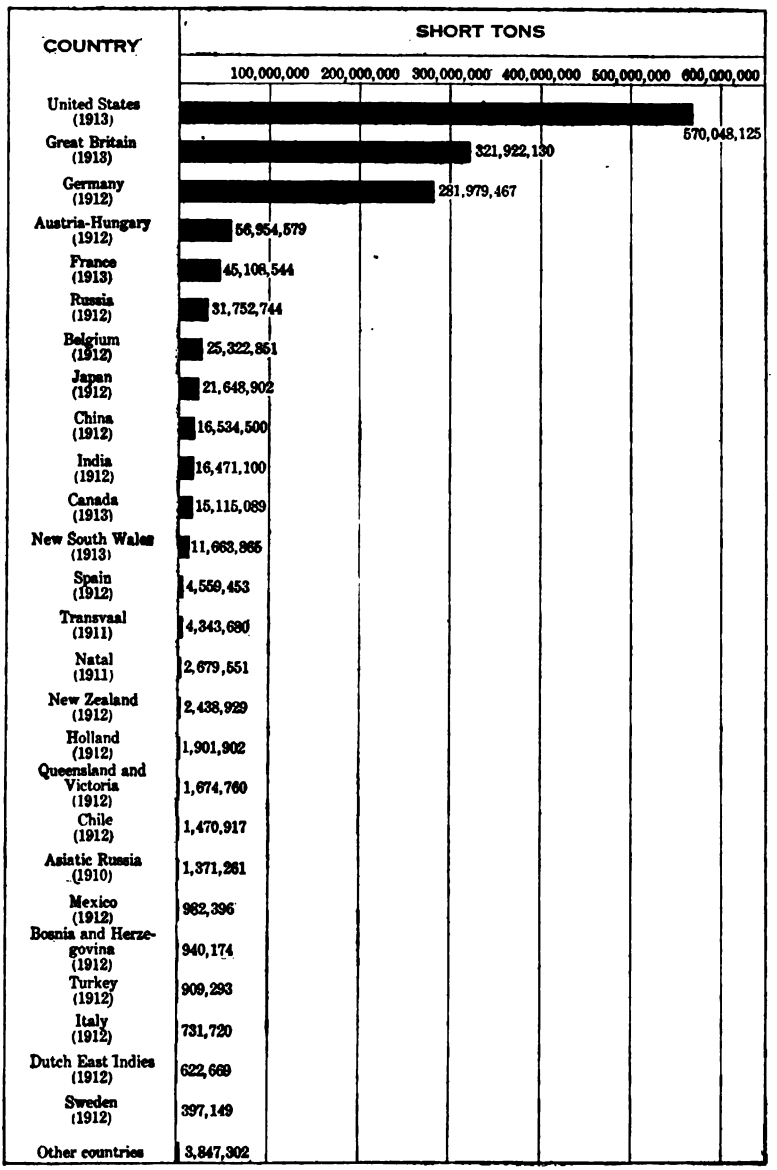

FIGURE 20.—World's production of coal.

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The world's production of coal.

Countries.	Usual unit in producing country.	Equivalent in short tons.
United States (1913)	long tons	508,971,540	570,048,125
Great Britain (1913)	do	287,430,473	321,922,130
Germany (1912)	metric tons	235,810,094	281,979,467
Austria-Hungary (1912)	do	51,668,855	56,954,579
France (1913)	do	40,922,203	45,108,544
Russia (1912)	do	28,805,900	31,752,744
Belgium (1912)	do	22,972,740	25,322,851
Japan (1912)	do	19,639,755	21,648,902
China (1912)	do	15,000,000	16,534,500
India (1912)	long tons	14,706,339	16,471,100
Canada (1913)	short tons	15,115,089	15,115,089
New South Wales (1913)	long tons	10,414,165	11,663,865
Spain (1912)	metric tons	4,136,309	4,559,453
Transvaal (1911)	long tons	3,878,286	4,343,680
Natal (1911)	do	2,392,456	2,679,551
New Zealand (1912)	do	2,177,615	2,438,929
Holland (1912)	metric tons	1,725,394	1,901,902
Asiatic Russia (1910)	do	1,244,000	1,371,261
Chile (1912)	do	1,334,407	1,470,917
Queensland (1912)	long tons	902,166	1,010,426
Mexico (1912)	metric tons	891,224	982,396
Bosnia and Herzegovina (1912)	do	852,920	940,174
Turkey (1912)	do	824,905	909,293
Italy (1912)	do	663,812	731,720
Victoria (1912)	long tons	593,155	664,334
Dutch East Indies (1912)	metric tons	564,882	622,669
Orange Free State (Orange River Colony) (1911)	long tons	430,973	482,690
Indo-China (1912)	metric tons	427,523	471,259
Peru (1912)	do	278,927	307,461
Servia (1911)	do	304,359	335,495
Sweden (1912)	do	360,291	397,149
Western Australia (1912)	long tons	295,079	330,488
Formosa (1912)	metric tons	278,455	306,941
Bulgaria (1911)	do	245,314	270,410
Rhodesia (1911)	long tons	189,758	212,529
Roumania (1911)	metric tons	242,025	266,784
British Borneo (1910)	long tons	171,366	191,930
Korea (1911)	metric tons	123,668	136,319
Cape Colony (Cape of Good Hope) (1911)	long tons	79,485	89,023
Tasmania (1912)	do	53,560	59,987
Spitzbergen (1911)	metric tons	40,000	44,092
Brazil (1911)	do	15,000	16,535
Portugal (1912)	do	15,366	16,938
Venezuela (1908)	do	14,064	15,503
Switzerland (1911)	do	7,500	8,267
Philippine Islands (1912)	do	2,720	2,998
Greece (1910)	do	1,500	1,653
Unspecified	long tons	250,000	280,000
Total			1,443,393,052
Percentage of the United States			39.5

As a matter of historical interest the following table, giving the statistics of the production of coal in the more important countries of the world since 1870, is presented. In the 44 years covered by this table the percentage of the total contributed by the United States increased from less than 15 to nearly 40. The largest percentage credited to the United States was in 1913, when this country produced 39.49 per cent of the world's total.

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World's production of coal, by countries, 1870–1913.

Year.	United States.		Great Britain.		Germany.	
	Long tons.	Short tons.	Long tons.	Short tons.	Metric tons.	Short tons.
1870	29,496,054	33,035,580	110,431,192	123,682,935	34,003,004	37,488,312
1880	63,822,930	71,481,570	146,969,409	164,605,738	59,118,035	65,177,634
1890	140,866,981	157,770,963	181,614,288	203,408,003	89,290,834	98,398,500
1900	240,789,310	269,684,027	225,181,300	252,203,056	149,551,000	164,805,202
1910	447,853,909	501,596,378	264,433,028	296,164,991	222,301,660	245,043,120
1911	443,188,505	496,371,126	271,891,899	304,518,927	234,259,061	258,223,763
1912	477,202,303	534,466,580	280,416,338	291,666,299	255,810,094	281,979,467
1913	508,971,540	570,048,125	287,430,473	321,922,130	.....	.....

Year.	Austria-Hungary.		France.		Belgium.	
	Metric tons.	Short tons.	Metric tons.	Short tons.	Metric tons.	Short tons.
1870	8,355,945	9,212,429	13,179,788	14,530,716	13,697,118	15,101,073
1880	14,800,000	16,317,000	19,361,564	21,346,124	16,886,098	18,617,585
1890	27,504,032	30,323,195	26,083,118	28,756,638	20,365,960	22,453,471
1900	39,029,729	43,010,761	33,404,298	36,811,536	23,462,817	25,856,024
1910	48,649,768	53,626,639	38,570,473	42,516,232	23,927,230	26,374,986
1911	49,859,655	54,960,298	39,229,591	43,242,778	23,053,540	25,411,917
1912	51,668,855	56,954,579	.....	.....	22,972,740	25,322,851
1913	51,668,855	56,954,579	40,922,203	45,108,544	22,972,740	25,322,851

Year.	Russia.		Japan.		Other countries.	Total.	Percentage of United States.
	Metric tons.	Short tons.	Metric tons.	Short tons.	Short tons.	Short tons.	
1870	667,806	735,922	.....	.....	1,063,121	234,850,088	14.07
1880	3,238,470	3,570,413	.....	.....	3,621,342	364,737,406	19.60
1890	6,016,525	6,633,219	2,653,000	2,923,606	13,025,637	563,693,232	27.99
1900	16,151,557	17,799,016	7,429,457	8,187,262	27,684,964	846,041,848	31.88
1910	22,650,000	24,967,095	15,681,324	17,285,523	71,445,828	1,279,020,792	39.22
1911	26,636,818	29,361,764	17,632,710	19,436,536	79,436,191	1,310,973,300	37.86
1912	28,805,900	31,752,744	19,639,755	21,648,902	[a] 82,934,740	[b] 1,369,968,940	39.00
1913	28,805,900	31,752,744	19,639,755	21,648,902	[a] 88,655,710	[b] 1,443,393,052	39.49

[a] For detailed statement see table on preceding page.
[b] Latest available figures are used in making up totals for 1913.

COAL-TRADE REVIEW.

It has been the practice in the preparation of the annual report on the production of coal to include reviews of the coal trade in some of the principal cities, and this custom has been followed in the present chapter. These reviews have been contributed chiefly by secretaries of chambers of commerce or other local authorities familiar with the coal trade of their respective communities. They will be found interesting, in that they reflect the conditions which have influenced the markets and the bearing they have had upon production. Acknowledgments of the services rendered is gratefully made and recognition by name is given for each contribution.

NEW YORK CITY.

By FREDERICK HOBART, associate editor of the Engineering and Mining Journal.

GENERAL CONDITIONS.

It can not be said that there were any marked changes apparent in the coal trade of New York City and vicinity during the year 1913. In the early part of the year business was active and demand

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reasonably good. Later on, especially in the last quarter of the year, there was a decided falling off, which was principally evident in bituminous coal and was due to a decreased demand from the manufacturing industries. There was also some falling off in the anthracite demand, due to the very mild weather which prevailed in November and December. It may be added that the latter decrease was more than made up during the very severe weather which marked the opening months of 1914. With regard to this weather demand, however, the difference between a mild and a cold month is not so great as might be supposed. So large a proportion of the so-called domestic coal supply in the city is consumed in the large buildings and apartment houses where fires are maintained and have to be maintained without much regard to the weather, that the difference in consumption is comparatively small. In fact, experts estimate that the actual change in consumption is not over 5 per cent, and certainly does not reach 10 per cent.

No material change can be reported in the methods of handling coal supply and deliveries in the city. As has before been noted in these reviews, rail coal coming to New York is delivered at the docks on the New Jersey side of the Hudson and is conveyed to the city mainly by barges and car floats. The facilities for handling at the railroad terminals are mainly good, but in the city, with the exception of a few large plants on the river front, they are rather slow and wasteful. The coal supply of New York costs its consumers more than it should, though it is difficult to see the way to any improvement. Complaint is made from time to time of the high cost of coal, but the expenses of unloading and delivering coal which are necessarily incurred by the distributers are so high that the profit in the trade is small. Even the large consumers, whose receipts amount to many tons daily, are unable to effect any considerable economies in this respect. Certainly no changes of any importance were made during the year under review.

All allowances for the causes of diminished consumption being made, it is estimated that the quantity of coal delivered in the New York district, which includes the city of New York and the immediate vicinity, was about 16,000,000 long tons, or rather less than in 1912. Of this quantity, 11,500,000 tons were anthracite [1] and 4,500,000 tons were bituminous coal. The quantity of bituminous consumed in the city is greater than is popularly supposed, for the reason that many large plants used a certain quantity of bituminous mixed with the small sizes of anthracite. The city ordinances forbid smoke, but this mixture can, with proper firing, usually be burned without any emission of black smoke. In addition to the coal consumed in the city, there is handled over the New York wharves yearly about 4,500,000 tons of bunker coal, or coal supplied to steamships, making a total of between 20,000,000 and 21,000,000 tons which comes to New York harbor yearly.

Although no exact statistics for the water movement are available, some 20 per cent of the total receipts are brought to New York Harbor

[1] According to confidential reports furnished the Geological Survey by courtesy of officials of the railroads entering New York harbor ports, the total receipts of anthracite at New York harbor in 1913 amounted to 13,935,347 tons, but no exact separation can be made of the quantities destined for local consumption and those forwarded to New England and elsewhere. After deducting Mr. Hobart's estimate of 11,500,000 tons as the consumption of New York and vicinity, it appears that the quantity transshipped was approximetely 2,500,000 long tons.

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by barges and sailing vessels. The main sources of bituminous supply are the Clearfield, Irwin, and Somerset districts in Pennsylvania, the Cumberland in Maryland, and the Fairmont in West Virginia. The Pittsburgh district in Pennsylvania also furnishes some coal, which is mainly bunker coal. The supplies arriving by water are chiefly from the Pocahontas and New River districts of West Virginia.

New York is not a coal-exporting port, most of the foreign coal going from Hampton Roads, Baltimore, or Philadelphia. Nevertheless, there were shipped from New York Harbor for foreign ports in 1913 about 175,000 tons of anthracite, 25,000 tons of bituminous, and 30,000 tons of coke. That coke shipments should come to this port is rather remarkable, but it is so recorded in the returns to the Department of Commerce.

The trade of New York divides itself naturally into anthracite and bituminous, and can be best treated under those separate heads.

ANTHRACITE TRADE.

The year opened with trade in a somewhat disturbed condition owing to a heavy snowstorm which had fallen a few days before, and had seriously interrupted the movement of cars. The storm itself had caused an increased activity, whereas the supply was sharply curtailed and dealers were anxiously searching for coal. The flurry was only temporary, however, and the market quickly quieted down. The list prices on January 1, which continued generally in force during the first quarter of the year, were for domestic sizes f. o. b. New York Harbor ports, $5 per ton for broken, $5.25 for egg and stove, and $5.50 for nut. Steam sizes were quoted on the same basis at $3.50 for pea, $2.75 for buckwheat, $2.25 for No. 2 buckwheat or rice, and $1.75 for barley. During most of the rest of the month the market showed a fair degree of activity. A little shortage of nut coal developed toward the end of the month, but this was soon made up as a fair supply came forward. Some coal was sold at a small discount by speculators who had bought supplies earlier in anticipation of a shortage, but this had only a passing effect on the market.

During February colder weather produced a little better demand for domestic sizes; steam sizes were also in good demand, and the first of the month a little shortage of buckwheat was in evidence, and some premiums were paid for that size. This did not affect regular trade so much however, as the "independent" and washery steam coal, which generally brings from 10 cents to 15 cents a ton below the list prices. During all February weather conditions continued good for the trade, and a fair business was reported.

During March the anthracite trade was quiet and rather slow, dealers naturally buying no coal, except what was necessary to fill their current demands, in view of the near approach of April. Steam coal eased off a little, and quotations on the 1st of March were $3.50 a ton for pea, $2.50 to $2.75 for buckwheat, $2 to $2.25 for rice, and $1.60 to $2 for barley. The lower quotations were generally for independent coal. Buying continued slow all through the month, and there was some slacking down in work at the collieries.

On April 1 the general reduction of 50 cents a ton for the summer discounts was announced, and there was naturally a rush to buy, although this rush was not quite so great as usual, for the reason

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that many retailers had fair stocks on hand which they were anxious to dispose of before filling up their yards. Under the reduced schedule, broken coal was quoted at $4.50 a ton f. o. b. New York Harbor ports, egg and stove $4.75, and nut $5. The summer discounts do not apply to steam sizes, which remained about the same, with prices if anything a little firmer. Throughout the month of April the trade continued to improve, and the total for the month figured up quite satisfactorily; in fact, toward the end of the month it was difficult to fill orders promptly.

On May 1, according to custom, 10 cents was taken off the summer discounts, as usual, making list prices 10 cents a ton higher for the month. This did not much affect the demand, which continued steady for the greater part of the month, with no special incident to mark its course. There was a little spurt about the close of the month.

On June 1 another 10 cents was taken off the summer discounts. The trade continued fairly active, however, and was considered good for a summer month. The companies were a little slow in making deliveries, as the Lake trade had set in actively, and there was considerable shipment of anthracite to Lake ports. The trade continued through the month with very little change, and there was no special rush at its close to save the further advance to be made on July 1.

In July the main incident was the passage by the Pennsylvania legislature imposing a tax of 2½ per cent on all anthracite mined in the State. The companies, of course, demurred to this tax, and proposed to test its constitutionality. Meantime they made it evident that it was their intention to pass it on to the consumers; an addition of 25 cents a ton on all domestic sizes was made, the list price being unchanged while the tax was billed as a separate item, and this practice was continued. The announcement of the additional price caused a little excitement, but for the most part it was accepted as inevitable. Trade was rather quiet during August, after another 10 cents had been taken off the discount, but perhaps not more so than is usual at this season.

On September 1 the remaining 10 cents was removed from the discount and quotations returned to the former list prices per ton—$5 for broken, $5.25 for stove and egg, and $5.50 for chestnut, with, of course, the addition of the tax, which made the rate really 25 cents above the figures given. Steam sizes continued steady at $3.50 a ton for pea, $2.75 for buckwheat, $2.25 for rice, and $1.75 for barley, with a range of 10 to 15 cents below those prices for individual coal. The quantity of washery coal coming forward, has diminished so much that that class of coal does not affect the market. The market continued irregular and uncertain through the month, principally owing to the rather slack demand for steam sizes.

The same conditions continued well on into October, and in fact during the greater part of that month. Retailers had generally all the stocks they could carry and domestic demand was not heavy.

November opened with mild, almost summer weather, and domestic requirements continued small. By way of stimulating the market, a slight scarcity of stove and nut sizes developed about the middle of the month, but that soon passed over, and trade resumed its

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moderate course. The demand for steam coal was still rather light. Late in the month there was a short spell of cold weather, but it did not last long enough to stimulate the demand.

For the month of December, the story is soon told. The weather continued mild, no special demand developed, supplies continued abundant, and sales were on a moderate basis. There had been an absence of snow, so that transportation and car supply were good, and the year closed with an exceedingly quiet trade, although, as the event proved, cold weather and storms were soon to develop a considerable activity. Domestic sales were probably up to the average during the year, but sales of steam sizes were light, on the whole; that is, so far as the current market was concerned. So large a proportion of those sizes, however, are sold under contract, with the prices fixed early in the year, that current demand has only minor effect.

BITUMINOUS COAL MARKET.

In January the market opened actively with a good demand. Supplies were temporarily rather small, owing to the recent storm, and the consequent disturbance in car supply and the movement of trains to tidewater. West Virginia coal was, perhaps, in largest quantity on the market for the time being. The current quotations f. o. b. New York harbor ports were $3.15 to $3.25 a ton for West Virginia, $3.10 to $3.25 for ordinary Clearfield, and $3.30 to $3.40 for best Miller vein Pennsylvania steam coal. Gas coal was in rather light demand. The market continued fairly strong through January, although supplies improved. At the close of the month, West Virginia coal seemed to be in rather oversupply, and there was a slight break, concessions of 5 and 10 cents being made to close sales.

At the beginning of February the market was weaker, West Virginia being quoted at $2.90 to $2.95, ordinary Clearfield at the same figure, and Miller vein at $3 to $3.05. About the middle of the month the market seemed to be suffering from a surplus of coal, and there was a sharp fall in prices, West Virginia coal being quoted at $2.65 to $2.75, Clearfield at $2.75 to $2.85, and Miller vein at $3.05 to $3.15.

This weakness continued into March, and the market for the greater part of that month was reported easier at current prices, with a tendency to make small discounts to secure trade. During March the usual dickering over yearly contracts began with the advantage, apparently, on the side of consumers, who held out for low prices. Sellers were not inclined to concede these, and the closing of contracts proceeded very slowly. Perhaps the only notable point in the month's trade was the larger offering of West Virginia coal.

In April the trade was better as far as volume was concerned, but prices were low, West Virginia coal being offered at $2.55 to $2.60 and Clearfield at $2.65 to $2.70, whereas good Miller vein held better than other sorts, being still quoted at $3.05 to $3.15. Contracting was on a somewhat better scale, although sellers refused to make lower prices for the year. Some large firms seemed to be keeping out of the market altogether, preferring to trust to the risks of the open market rather than to keep themselves tied up by long contracts. As usual, there was later a difference of opinion as to the judiciousness of this course. Toward the end of the month there

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were reports of offering of low-grade coal at very cheap prices, but these seem to have been exaggerated, and they were not on a scale large enough to cause any serious disturbance.

In May the market opened a little heavy, but speedily stiffened up under a stronger demand. There was some call for spot lots, and when this was supplied business quieted down a little, but prices remained steady, and there was very little change from those quoted above. At the end of the month some demurrage coal, the first which made its appearance in any quantity during the year, was offered, at rather low prices, but this was soon disposed of.

In June, during the first half of the month, business was fairly good. Yearly contracts were out of the way for the most part, and the demand was sufficient to dispose of the current arrivals at tidewater. Prices at the opening of the month were $2.50 to $2.60 for West Virginia, $2.60 to $2.70 for ordinary Clearfield, and $3 to $3.10 for best Miller vein. For most of the month demand continued strong, and in some cases premiums of 5 cents a ton were paid for prompt deliveries. A feature of the month, or at any rate for the first half, was a heavy call for gas coal, which was temporarily rather scarce. Good arrivals, however, supplied this demand, and business resumed its usual course. Toward the end of the month the market grew firmer, partly on account of the West Virginia strikes and partly because of the diversion of coal to the West for the Lake trade, which set in well at this time.

The month of July opened with a good demand, and supplies were rather lighter on account of a shortage of labor and the disturbances in West Virginia. Some trouble also developed about car supply, and it was toward the middle of the month before this difficulty was adjusted. Trade continued good all through the month, and the market closed firm, with West Virginia quoted at $2.65 to $2.70, good Clearfield at $2.75 to $2.80, and best Miller vein at $3.10 to $3.20.

The market continued firm well into August, and prices were generally held, although a little irregularity was noted at one time. The tone of the market was, generally speaking, rather easier.

September marked the continuance of this easier tone, although sellers managed to hold prices fairly well. Demand, however, showed some falling off, which was not promising for the future. This was balanced by slow arrivals, due to a scarcity of cars in the mining region and consequent delay in shipments. A little improvement in this respect brought about an easier condition toward the end of the month.

In October supplies continued rather scarce, and gave an appearance of firmness, in spite of some moderation in the demand. It is noticeable that the rush to buy coal for the shoal-water ports before those ports are closed by ice was rather less than usual; in fact, it made no serious impression on the trade. Apparently those ports had laid in stocks which were considered sufficient in the regular course of trade, and did not feel the necessity of any special provision late in the season.

In November, slow movement, due to railroad congestion and labor troubles, made the market still firmer, this condition being helped by the unusual number of firms not under yearly contract. The first week in the month there was an advance in prices, West Virginia being quoted at $2.75 to $2.85, ordinary Clearfield at $2.85 to $2.95,

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and Miller vein at $3.15 to $3.25. During the rest of the month the market was much quieter, and some shading of prices was reported, the particulars of which were difficult to obtain.

In December the current demand was reported still slow. A strong effort was made to hold prices, but about the middle of the month a decline of at least 5 cents was noted, West Virginia being quoted at $2.65 to $2.75, good Clearfield at $2.70 to $2.80, and Miller vein at $3.05 to $3.20. A little later there was a still further decline, coal being offered to good buyers at fully 10 cents below quoted prices. Some demurrage coal also made its appearance at a discount of 15 cents to 20 cents a ton from the list prices. The market for the year closed upon the whole dull and weak, with not a very good prospect for the opening year. Supplies arriving were moderate only, but apparently sufficient for the demand.

COASTWISE TRADE.

The coastwise trade in 1913 was remarkably free from incident, and there were comparatively few changes in rates. An increasing share of the bituminous business was taken by the barges, which are either operated by the large companies or are under contract, and which already held most of the anthracite traffic. Chartering was slow and most of the sailing vessel business appeared to be done from Philadelphia, Baltimore, and Hampton Roads, New York taking only a moderate share of it. The vessel business, in fact, can not be made the subject of an extended review from this port, so much of it being done by barges or from other ports.

There was, as usual, a good deal of complaint of delays at the sound ports, the rail shipments from which are controlled by the New Haven road, which still seems to be firm in its policy of diverting as much as possible of the coal going to central and western New England to the all-rail lines and is not inclined to help out the water business. Otherwise, the trade has been without incidents of importance.

There is some speculation as to whether the opening of the Cape Cod Canal next year will have much influence on the trade. It is not likely that much difference will result; at least, that is the view of many coasting captains. The canal tolls will be higher than can be counterbalanced by the extra time necessary for the outside trip, and probably few coal-laden boats will take the canal, except in cases of emergency or of long continued stormy weather.

PHILADELPHIA, PA.

[From FREDERICK E. SAWARD'S annual volume, The Coal Trade.]

The year 1913 was a time of contradictions in the Philadelphia coal trade. Weather conditions were remarkable, in that when business should have been brisk the thermometer stubbornly refused to lend its aid. Prices, despite this fact, held up very well, so much so that in both branches of the industry quotations were maintained on an extraordinary level, and not until the close of the year was there any appreciable decline.

In the anthracite trade the year opened with warm weather. The result was that both wholesale and retail business was rather dull. Premiums, which had been in vogue in the fall months of 1912, went out of fashion.

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The first real day of winter came early in February, and throughout the rest of that month seasonal weather prevailed, resulting in the ready absorption and consumption of a normal production. The next month thrifty retailers began to look for bargains at April prices. The merchants were not disappointed, for wholesale prices broke badly in the early part of March and the general curtailment of winter production had to be resorted to to prevent the market from being flooded. The retail trade held its prices to the consumer fairly well, but began to anticipate spring orders in the latter part of the month at the April discount quotations.

The opening prices for April were: Wholesale at mines, broken, $3; egg, $3.25; stove, $3.50; chestnut, $3.65; pea, $2.50. Retail, broken, $6.50; egg, $6.50; stove, $6.75; nut, $7; pea, $5.50. Less 25 cents for cash.

Ten cents were added to the prices, except on that for pea, on the first of each succeeding month until the winter schedule was in force again.

Trade continued normal throughout the spring months. The wholesaler kept to the fore the bogie of the 1912 scarcity and so managed to turn out a fair production, slightly better, indeed, than would have been seen under ordinary conditions.

The fall was exceptionally mild, and until Christmas there was no evidence of real winter weather. Suspensions were necessary, therefore, in December. The retailer, early in December, advanced prices 25 cents a ton, making them: Egg, $7; stove, $7.25; chestnut, $7.50; pea, $5.50; with no discount for cash.

In the bituminous trade the year opened with prices at high tide. A boom had begun in November of 1912, and the quotations at the beginning of 1913 stood at $1.75 to $2.

The open winter was unusually favorable for production and freight movement. The consumer felt very comfortable and, even though there was a show of winter in February, prices fell gradually to $1.40 to $1.50 for good grades.

There was no wage scale to upset business, so conditions continued normal throughout the spring. In April contracts were closed at slightly higher prices than in 1912. The demand was good, with quotations at $1.25 to $1.35, for good grades; South Fork and other higher grades, $1.50; cheap grades, $1.10 to $1.15.

As summer drew on, there was an acute need of getting men for the mines. July, August, and September saw an unusual demand, the mines working as full as possible, being hampered, however, by scarcity of labor and occasional car shortage. Labor troubles in the southern field stimulated the demand for Pennsylvania coal in New England. Prices for good grades were $1.40 to $1.50, and for cheaper grades, $1.15 to $1.25.

In the fall months the region obtained more men; cars were more plentiful, and the output greater than in the summer. Still, the trade absorbed the increased tonnage with very little easing off in prices.

Despite the summery December, conditions were fairly satisfactory in the last months of the year. Very little coal was sacrificed. The year closed with prices probably as low as at any time in 1913 for the cheaper grades—95 cents to $1.05. It should be noted that throughout the year the better grades of coal held firm in price,

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which showed a profit over cost of production, while in 1912 the very best coal was sacrificed at times.

Mr. Frank L. Neall, manager Consolidated News, Statistics and Transportation Bureau, Philadelphia, reports that the coastwise shipments from Philadelphia in 1913 consisted of 1,396,271 long tons of anthracite and 1,901,109 tons of bituminous coal. The local consumption of anthracite in 1913, as reported by Mr. Neall, was 3,775,701 long tons, as compared with 3,774,987 tons in 1912. The exports amounted to 63,481 long tons of anthracite, valued at $292,922, and 915,145 tons of bituminous coal, valued at $2,603,915. The bulk of both the anthracite and the bituminous coal was exported to Cuba, that country taking 40,269 tons of anthracite, valued at $176,400, and 525,756 tons of bituminous coal, valued at $1,486,656.

The following table shows the freight rates from the mines to Philadelphia:

Freight rates per long ton on anthracite from coal regions to Philadelphia, Pa.

Region.	Prepared sizes.	Pea.	Buckwheat.
Schuylkill	$1.70	$1.40	$1.25
Lehigh	1.75	1.45	1.30
Wyoming	1.80	1.50	1.35

The average range of retail prices for anthracite and bituminous coal during the last two years, by months, has been as follows:

Average prices for anthracite and bituminous coal at Philadelphia in 1912 and 1913, by months, per long ton.

Month.	Chestnut.	Prepared sizes.	Pea.	Buckwheat.	Rice.	Bituminous.
January	$6.75–$7.00	$6.50–$7.00	$4.75	$3.35–$3.75	$2.75–$3.10	$3.75–$4.00
February	6.75– 7.00	6.50– 7.00	4.75	3.35– 3.75	2.75– 3.10	3.75– 4.00
March	7.00– 7.50	6.50– 7.00	$4.75– 5.00	3.50– 3.80	2.75– 3.25	3.75– 4.50
April	7.00– 7.50	6.75– 7.25	4.75– 5.00	3.50– 4.00	2.75– 3.25	3.75– 4.50
May	6.75– 7.00	6.50– 6.75	4.75– 5.00	3.30– 3.75	2.75– 3.10	3.50– 4.75
June	6.50– 6.75	6.50– 6.75	4.50– 4.75	3.25– 3.50	2.50– 3.00	3.00– 4.00
July	6.75– 6.85	6.50– 6.85	4.50– 4.75	3.25– 3.50	2.50– 3.00	3.00– 4.00
August	6.75– 6.95	6.50– 6.85	4.50– 4.75	3.20– 3.75	2.50– 3.10	3.00– 4.00
September	7.00– 7.25	6.25– 6.75	4.50– 4.75	3.35– 3.75	2.50– 3.10	3.25– 4.00
October	7.00– 7.25	6.50– 7.00	4.50– 4.85	3.35– 3.75	2.50– 3.10	3.25– 4.00
November	7.00– 7.25	6.50– 7.00	4.50– 4.85	3.35– 3.75	2.50– 3.10	3.40– 4.00
December	7.00– 7.25	6.50– 7.00	4.50– 4.85	3.35– 3.75	2.50– 3.10	3.50– 4.00

The price circular of the Philadelphia & Reading Coal & Iron Co., which is the same as that of other companies, and is for coal delivered on board vessels at Port Richmond, Philadelphia, for shipment beyond the capes of the Delaware, was as follows, subject to the usual discount of 50 cents a ton in April; 40 cents in May; 30 cents in June; 20 cents in July; and 10 cents in August:

Circular prices for anthracite delivered at Port Richmond, Philadelphia, in 1913, per long ton.

	Broken.	Egg.	Stove.	Chestnut.
Free white ash	$4.75	$5.00	$5.00	$5.25
Hard white ash	4.85	5.00	5.00	5.25
Shamokin	.....	5.25	5.25	5.25
Schuylkill red ash	.....	5.50	5.50	5.50
Lorberry	.....	5.50	5.50	5.50
Lykens Valley	5.75	6.00	6.00	6.00

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BOSTON, MASS.

By ROBERT S. COFFIN, secretary of the committee on fuel supply, Boston Chamber of Commerce.

Receipts and shipments.—The receipts of coal at Boston during the year 1913 were the largest in the history of the port. There was an increase of more than half a million tons over the previous year. The aggregate receipts of anthracite and bituminous amounted to 7,115,993 long tons, as against 6,578,017 long tons in 1912, an increase of 537,976 long tons. Of the receipts for 1913, 1,854,450 tons were anthracite, 4,991,884 tons were domestic bituminous coal, and 269,659 tons were foreign bituminous. This was an increase of 135,318 tons of anthracite and of 442,125 tons of domestic bituminous, but a decrease of 39,467 tons of foreign bituminous.

There was a good demand for all kinds of coal in the early part of the year, owing in part to activity in many lines of industry; on the other hand, there was an adequate supply of coal to fill the demand, a condition in strong contrast to the distressing shortage of 1912.

A considerable tonnage of the coal received at Boston is forwarded over the railroads to interior New England points. In 1913, 98,244 tons, or about 5 per cent, of the anthracite receipts and 1,073,832 tons, or about 20 per cent, of the bituminous coal received at Boston were reshipped to interior points. The net receipts, for local consumption, amounted to 1,756,206 tons of anthracite and 4,187,711 tons of bituminous coal.

The following table shows the receipts of both anthracite and bituminous coal at Boston, by months, for 1913, the quantity forwarded to interior points, the net receipts for local consumption, and the total for 1913 as compared with the totals for the three preceding years:

Receipts and shipments of coal at and from Boston in 1913, by months, in long tons.

1913	Receipts from all points.		Amount forwarded to New England points.		Net receipts (for local consumption).	
	Anthracite.	Bituminous.	Anthracite.	Bituminous.	Anthracite.	Bituminous.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
January	187,148	382,653	3,280	84,543	183,868	298,110
February	121,783	419,825	4,532	82,998	117,251	336,827
March	104,427	458,191	2,438	105,265	101,989	352,926
April	143,016	463,409	17,192	82,288	125,824	381,121
May	173,069	430,950	8,771	76,786	164,298	354,164
June	164,759	445,598	8,347	71,549	156,412	374,049
July	166,802	431,854	13,332	82,462	153,470	349,392
August	168,506	496,483	7,938	97,826	160,568	388,657
September	169,924	447,871	15,046	99,237	154,878	348,634
October	126,968	394,479	6,230	94,471	120,738	300,008
November	153,185	410,851	3,101	99,759	150,084	311,092
December	174,863	489,379	8,037	96,648	166,826	392,731
Total, 1913	1,854,450	5,261,543	98,244	1,073,832	1,756,206	4,187,711
1912	1,719,132	4,858,885	142,407	1,179,491	1,576,725	3,679,394
1911	1,962,940	4,435,091	246,610	1,235,228	1,736,330	3,199,863
1910	1,826,164	4,403,858	241,641	743,635	1,584,523	3,660,223

The following table shows the receipts of domestic and foreign coal at the port of Boston for a period of 10 years, in long tons.

The only receipts of foreign coal, as usual, were from the bituminous mines of the Dominion Coal Co., Cape Breton, practically the entire

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tonnage of which was consigned to the by-product coking plant at Everett, a suburb of Boston.

Receipts of coal at Boston, Mass., in 1904–1913, in long tons.

Year.	Domestic.				Foreign.	Total.
	By water.		By rail.			
	Anthracite.	Bituminous.	Anthracite.	Bituminous.	Bituminous.	
1904	1,961,785	2,397,885	40,994	117,605	550,383	5,068,652
1905	1,941,478	2,757,186	35,920	41,104	608,471	5,384,159
1906	1,630,674	2,772,593	29,005	87,251	658,072	5,177,595
1907	2,016,252	3,196,057	37,086	89,927	545,652	5,884,924
1908	1,733,112	3,240,862	43,289	62,367	370,709	5,450,039
1909	1,668,126	3,393,423	38,533	101,588	228,297	5,429,967
1910	1,760,883	3,954,251	65,281	153,043	296,564	6,230,022
1911	1,881,767	4,101,745	101,173	69,485	263,861	6,418,031
1912	1,554,156	4,475,820	164,976	74,239	309,126	6,578,017
1913	1,676,311	4,944,087	178,139	47,197	269,659	7,115,993

Anthracite.—The retail prices of anthracite in 1913 were lower than in 1912, but somewhat higher than normal. The increased cost of labor in the handling and distribution of coal makes it unlikely that the lower prices of a few years ago will again be reached. Within the last two years local coal companies have made advances in wages to their employees amounting to approximately $2 a week, and other expenses have increased in like proportion.

The first reduction from the abnormally high winter prices was made February 1, when a reduction of 25 cents a ton was made on all sizes. The summer prices went into effect on the usual date, April 1, when all sizes were reduced 75 cents a ton, with the exception of nut coal, which was reduced 50 cents a ton. This was 25 cents a ton lower than the summer prices of 1912. On July 1 the prices on all sizes were advanced 25 cents a ton, and two further advances of 25 cents each were made on August 2 and October 2.

Retail prices, per short ton, of anthracite at Boston in 1913, by kinds.

Kind.	Feb. 1.	Apr. 1.	July 1.	Aug. 2.	Oct. 2.
Furnace	$7.25	$6.50	$6.75	$7.00	$7.25
Egg	7.75	7.00	7.25	7.50	7.75
Stove	8.00	7.25	7.50	7.75	8.00
Nut	8.00	7.50	7.75	8.00	8.25
Pea	6.25	5.50	5.75	6.00	6.25
Shamokin	8.25	7.50	7.75	8.00	8.25
Franklin	9.25	8.50	8.75	9.00	9.25

Coastwise freight rates.—The coastwise freight rates in 1913 were slightly higher than normal. There was decidedly less fluctuation in 1913 than for several years. The volume of coal carried to Boston in sailing vessels has steadily decreased, while the tonnage carried in steam colliers has steadily increased. Coal steamers almost exclusively are on Government form, which calls for a per diem charge rather than a rate per ton, and it is, therefore, difficult to make comparisons in rates. On the other hand, most sailing vessels in the trade are taken on season charters at a reasonable rate through several months, if not for the entire year. All this tends to make

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rates steadier. Most of the coal shipped to New England came in steamers and other vessels under contract, and the current demand was light throughout the year.

From Hampton Roads the minimum rate in 1913 was 70 cents a ton and the maximum rate was $1 a ton, as compared with rates ranging from 60 cents to $1.50 a ton in 1912; the rates from Philadelphia in 1913 ranged from 70 cents to $1.25, as compared with rates ranging from 75 cents to $1.25 in 1912; from Baltimore the rates in 1913 ranged from 75 cents to $1.10 a ton, as against 75 cents to $1.25 a ton in 1912. In general, freights were on a basis of 70 cents to 75 cents a ton to Boston. A number of season charters were closed at these rates, and it was the exception when a schooner or barge got a higher freight after March 1. During the latter part of the year there was a surplus of steam, sail, and barge transportation.

Coal freights to Boston during 1912 and 1913.

1912.

From—	Minimum.		Maximum.	
	Rate.	Date.	Rate.	Date.
New York	[a] $0.50–$0.55		$1.25	Mar. 15–Apr. 15.
Philadelphia	.65	May 20–June 15	1.30	Feb. 26.
Baltimore	.75	June 25	1.25	Feb. 13.
Norfolk and Newport News	.60	June 20	1.50	Mar. 16.

1913.

New York	[a] $0.50–$0.55		$1.25	Jan. 30.
Philadelphia	[b] .70– .80	Mar. 15–Nov. 1	1.25	Jan. 15–Jan. 30.
Baltimore	[b] .75	June 1–Aug. 1	1.10	Jan. 15.
Norfolk and Newport News	[b] .70– .75	June 15–Sept. 1	1.00	Jan. 1–Mar. 1.

[a] 50 to 55 cents was season rate on anthracite coal-carrying railroad transportation from New York and 75 cents from Philadelphia. 70 cents was the minimum rate on sail (sailing vessels) tonnage from New York to Boston.

[b] These rates apply to sail tonnage. Large number of season charters—that is, for 8 to 10 to 12 trips at 70 to 75 cents, most of the sail transportation being closed on that basis rather than from trip to trip as in former years.

BALTIMORE, MD.

By Samuel G. Wilmer, financial editor of the Manufacturers' Record.

There was a considerable increase in the coal trade at the port of Baltimore during the year 1913 as compared with 1912. Business once more took an upward turn and the combined gross receipts of bituminous coal and anthracite displayed an advance of about 6½ per cent in volume. There were no serious labor conditions to affect business as there were in 1912, when, owing to troubles in the mining regions, receipts were restricted and trading was generally unsatisfactory notwithstanding good prices. In 1913 prices continued fair for bituminous and the local business was large, being, according to the expressed opinion of an authority, the greatest in the history of the coal trade. Prices declined in the latter part of the year in spite of some strikes at mines, the drop being due to pressing coal for sale upon purchasers already supplied, shipments being pushed forward from stock of fuel previously accumulated.

Receipts of bituminous coal amounted to 5,842,437 long tons, or 220,172 tons (nearly 4 per cent) more than in 1912. Receipts of anthracite were 1,039,965 long tons, or 198,360 tons (over 22 per cent)

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more than in 1912. Receipts of coke also went up, and heavily, their increase being 207,103 short tons in a total of 345,898 tons, or nearly 150 per cent over the previous year. This gain was in the main due to enlarged purchases of coke by the Maryland Steel Co., which also makes much of the coke it uses in by-product ovens at its steel plant. Alterations in the coking plant which were begun in the latter part of the year made larger purchases necessary.

In fact, all the statistics of Baltimore's coal trade for 1913 are marked by increases, except in the single matter of anthracite exports, which were almost nothing, for not a pound of anthracite was exported in the last half of 1913, and little was sent out in the first half. Coastwise shipments of bituminous coal amounted to 3,655,796 tons, an increase of 38,514 tons, and similar shipments of anthracite were 261,316 tons, or 44,174 tons more than in 1912. Hence the coastwise shipments of both aggregated 3,917,112 tons, or 82,688 tons more than the total of 1912. Exports of bituminous coal were 870,651 tons, an increase of 242,129 tons, and exports of anthracite were only 2,662 tons. Coke exports were 63,377 tons, an increase of 8,763 tons.

Of anthracite it may be said that prices are always firm. This fuel is used in Baltimore almost exclusively for domestic purposes, and, owing to the warm winter of 1912–13, the consumption was smaller than usual; the mild temperature during January broke the record for many years. The quantity of anthracite consumed at industrial plants is practically nothing. There has, however, been a little increase in the use of very small hard coal for heating in apartment houses and, in one or two instances, in private dwellings. Furnaces with grates adapted to burning the buckwheat size of anthracite have been installed and, it is understood, with satisfactory results, but there is small probability of any large increase in its use. In this market bituminous coal, by reason of its lower price, as well as on account of its better steaming quality, commonly takes precedence over the very small hard coal for heating apartment houses, office buildings, and other large edifices. Generally the anthracite trade was without particular feature, and receipts were normal.

In the accompanying tables the receipts and shipments of both bituminous and anthracite coal are shown and included are the coal and coke used at the extensive works of the Maryland Steel Co. at Sparrows Point, and at the plant of the Central Foundry Co. at Dundalk, both plants being near Baltimore and always included in any estimate of the local coal business, as their purchases are practically part of it.

Receipts and shipments of coal and coke at Baltimore, Md., 1912–13, in long tons.

Kind.	1912			1913		
	Receipts.	Tidewater shipments.		Receipts.	Tidewater shipments.	
		Coastwise.	Exports.		Coastwise.	Exports.
Bituminous	5,622,265	[a] 3,617,282	628,522	5,842,437	[a] 3,655,796	870,651
Anthracite	841,605	217,142	3,876	1,039,965	[a] 261,316	2,662
Total	6,463,870	3,834,424	632,398	6,882,402	3,917,112	873,313
Coke (short tons)	138,795	.....	54,614	345,898	.....	63,377

[a] Includes shipments to points on Chesapeake Bay and in Baltimore Harbor.

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Coastwise shipments of coal from Baltimore, 1903–1913, in long tons.

Year.	Anthracite.	Bituminous.	Total.
1903			1,731,896
1904	238,728	2,064,060	2,302,788
1905	252,568	2,832,321	3,084,889
1906	238,162	3,176,710	3,414,872
1907	266,062	3,804,066	4,070,128
1908	251,739	3,704,851	3,956,590
1909	235,233	3,344,225	3,579,458
1910	272,695	3,891,018	4,163,713
1911	276,766	4,135,493	4,412,659
1912	217,142	3,617,282	3,834,424
1913	261,316	3,655,796	3,917,112

It will be observed that the increase in export of bituminous coal was again large as compared with that of 1912, and there was also an increase in coke export, although it was comparatively small. The following table displays the exports of these fuels month by month during 1913 and also for the entire year, together with the total for each twelvemonth during the preceding eight years.

Exports of bituminous coal and coke from Baltimore in 1913, by months, in long tons.

Month.	Coal.	Coke.
January	82,194	458
February	66,106	3,116
March	69,799	558
April	90,630	10,396
May	88,138	9,144
June	110,091	3,978
July	82,869	2,919
August	38,385	11,590
September	45,403	10,326
October	60,465	3,592
November	60,873	6,934
December	75,798	366
Total, 1913	870,651	63,377
1912	628,522	54,614
1911	479,096	98,285
1910	493,416	46,847
1909	332,016	50,446
1908	347,489	105,317
1907	559,880	77,822
1906	458,203	69,230
1905	341,107	32,954

The following statements exhibit the receipts of bituminous coal and coke at the respective plants of the two large industries previously named herein:

Maryland Steel Co.—Bituminous coal consumed at the plant of the Maryland Steel Co. in 1913 amounted to 518,130 long tons. In its own ovens the company manufactured 206,582 short tons of coke and it also bought 191,740 tons, all of which was used in its manufacturing processes. In 1912 it used 558,985 tons of bituminous coal and made in its ovens 262,832 tons of coke, besides buying 47,720 tons of the latter.

Central Foundry Co.—At the plant of the Central Foundry Co. during 1913 there were consumed 2,836 long tons of bituminous coal and 3,185 short tons of coke. In 1912 the consumption of these fuels was 2,890 tons of bituminous coal and 2,647 tons of coke.

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In the preparation of the figures used in this article these two manufacturing companies and the Baltimore & Ohio, the Pennsylvania, and the Western Maryland railroad companies furnished hearty and courteous assistance, which is hereby acknowledged.

NORFOLK AND NEWPORT NEWS, VA.

The well-known steam and "smokeless" coals mined in the southern part of West Virginia and in the southwestern counties of Virginia reach tidewater at the mouth of Chesapeake Bay over the Chesapeake & Ohio Railway to Newport News, the Norfolk & Western Railway to Lambert Point, and the Virginian Railway to Sewall Point, the last two being on the south side of Hampton Roads, near Norfolk, and the Chesapeake & Ohio terminals being on the north side of "The Roads." The three terminals make this harbor second only to New York as a coal-handling port.

The quantity of coal, entirely bituminous, handled at the Hampton Roads ports in 1913 was about 150,000 long tons less than in 1912, when the high record of 11,850,706 long tons was made. All of the decrease was in bunker coal, which fell off from 1,659,603 tons in 1912 to 1,391,088 tons in 1913. This trade had been abnormally large in 1912, with an increase of nearly 538,000 tons over 1911. The bunker trade in 1913 showed a normal increase over two years before. Shipments over the Norfolk & Western Railway to Lambert Point increased from 4,980,984 long tons in 1912 to 5,410,060 tons in 1913, and those over the Virginian Railway to Sewall Point from 2,474,052 tons to 3,283,926 tons. Shipments over the Chesapeake & Ohio Railway to Newport News decreased, probably on account of the labor troubles in the Kanawha field, from 4,395,670 tons to 3,012,356 tons.

For the figures included in the following table the writer is indebted to the following officials, namely: Messrs. Joseph W. Coxe, comptroller, Norfolk & Western Railway, at Roanoke, Va.; W. A. Young, superintendent coal terminals, Virginian Railway, at Sewall Point, Norfolk, Va., and E. D. Hotchkiss, general freight agent, Chesapeake & Ohio Railway, at Richmond, Va.

The coal receipts at Hampton Roads in 1912 and 1913 are shown in the following table:

Coal receipts at Hampton Roads in 1912 and 1913, in long tons.

Destination.	Norfolk & Western Ry.	Chesapeake & Ohio Ry.	Virginian Ry.	Total.
1912.				
Coastwise	3,186,956	2,637,000	1,842,490	7,666,446
Export	1,193,711	917,514	254,476	2,365,701
Bunker	600,317	682,200	377,086	1,659,603
Local	.....	158,956	.....	158,956
Total	4,980,984	4,395,670	2,474,052	11,850,706
1913.				
Coastwise and local	3,407,592	1,714,691	2,683,271	7,811,554
Export	1,362,639	911,368	235,873	2,503,880
Bunker	639,829	386,477	364,782	1,391,088
Total	5,410,060	3,012,536	3,283,926	11,706,522

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The monthly shipments over the Virginian Railway in 1913, as reported by Mr. Young, were as follows:

Statement of coal dumped over Sewall Point Pier, 1913, by months, in long tons.

Month.	Coastwise.	Export.	Bunker.	Total.
January	180,345	48,339	31,859	260,543
February	202,945	26,673	28,565	258,183
March	215,860	17,413	28,190	261,463
April	209,828	15,713	23,684	249,225
May	215,078	29,796	36,663	281,537
June	182,816	34,831	37,111	254,758
July	183,410	12,618	25,036	221,064
August	247,100	10,557	25,728	283,385
September	265,935	7,909	26,744	300,588
October	254,740	9,887	40,152	304,779
November	296,445	9,366	32,958	340,769
December	226,769	12,771	28,092	267,632
Total	2,683,271	235,873	364,782	3,283,926

The shipments over the Norfolk & Western Railway to Lambert Point piers, as reported by Mr. Coxe, were as follows:

Statement of coal dumped over Lambert Point piers, 1913, by months, in long tons.

Month.	Coastwise.	Export.	Bunker.	Total.
January	276,804	128,627	63,980	469,411
February	308,274	108,337	50,590	462,201
March	294,994	106,585	51,870	453,449
April	293,880	131,936	50,895	476,711
May	306,041	130,043	54,212	490,296
June	235,110	158,480	51,971	445,561
July	287,290	139,074	59,461	485,825
August	329,565	89,729	47,727	467,021
September	264,173	96,307	41,825	402,305
October	278,706	94,022	59,360	432,088
November	240,735	44,780	47,229	332,744
December	297,020	134,719	60,709	492,448
Total	3,407,592	1,362,639	639,829	5,410,060

The monthly shipments of coal over the Chesapeake & Ohio Railway in 1913, at Newport News, as reported by Mr. Hotchkiss, were as follows:

Shipments of coal to Newport News, 1913, by months, in long tons.

Month.	Coastwise and export.	Bunker.	Total.
January	181,972	38,018	219,990
February	237,138	35,976	273,114
March	246,262	25,303	271,565
April	260,603	36,476	297,079
May	255,132	31,968	287,100
June	212,785	36,775	249,560
July	162,601	35,460	198,061
August	251,281	26,386	277,667
September	223,790	31,754	255,544
October	194,981	27,827	222,808
November	168,504	29,328	197,832
December	231,010	31,206	262,216
Total	2,626,059	386,477	3,012,536

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The total shipments from Virginia and southern West Virginia coal mines to Hampton Roads during the last five years have been as follows:

Shipments of coal to Hampton Roads, 1909–1913, in long tons.

Year.	Norfolk & Western Ry. to Lambert Point.	Chesapeake & Ohio Ry. to Newport News.	Virginian Ry. to Sewall Point.
1909	3,228,854	4,985,426	241,644
1910	4,040,649	4,409,848	1,147,077
1911	3,923,098	4,390,554	2,012,483
1912	4,980,984	4,395,670	2,474,052
1913	5,410,060	3,012,536	3,283,926

PITTSBURGH, PA.

The city of Pittsburgh, with a population in 1913 estimated at less than 550,000 persons, consumes nearly as much coal as Greater New York, with a population of approximately 5,000,000. If to the coal is added the coke, without including the natural gas used, Pittsburgh's consumption of fuel largely exceeds that of the great metropolis. No accurate data regarding the annual consumption of coal in New York are available, but it is estimated that the consumption, including the boroughs of Richmond, Queens, and The Bronx, is between 18,000,000 and 20,000,000 short tons of coal annually. From statistics compiled by the Geological Survey the consumption of coal alone in the city of Pittsburgh in 1913 was 18,538,676 short tons. If to this is added 5,000,000 tons of coke consumed in the Pittsburgh district, the total consumption of the solid mineral fuel was about 23,500,000 short tons, or 10 per cent more than all the boroughs of Greater New York together. The total coal business of Pittsburgh in 1913, local consumption and the shipments to points east and west included, was almost exactly 64,300,000 short tons. The coke used and handled in the district was approximately 15,000,000 tons, making a total of about 79,000,000 tons of solid fuel. The total quantity of coal sent to New York Harbor ports for local consumption, for bunker trade, and for transshipment is between 35,000,000 and 40,000,000 short tons, from which it appears that the total quantity of coal handled in Pittsburgh is about twice as much as that sent to New York Harbor ports. The quantity of coal shipped to the Pittsburgh district in 1913 was 18,538,676 short tons, an increase of 816,893 tons over 1912. The shipments from the Pittsburgh district to points west of Pittsburgh was 28,633,569 short tons, an increase of 2,554,218 tons. The total quantity of coal shipped by rail and water to the Pittsburgh district and through Pittsburgh to points west in 1913 was 47,172,245 short tons against 43,801,134 tons in 1912. The shipments to Pittsburgh by rail in 1913 were 8,203,091 short tons and by slack-water navigation 10,335,585 tons. The shipments to points west of Pittsburgh by rail were 26,044,234 short tons and by water 2,589,335 tons. The shipments from the Pittsburgh district to eastern points, which go all rail and do not pass through the city, amounted in 1913 to 17,127,692 short tons, against 15,349,045 tons in 1912.

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The shipments of coke to Pittsburgh in 1913 were 5,071,509 short tons (against 4,962,207 tons in 1912); to points west of Pittsburgh, 5,422,164 short tons (against 5,684,566 tons in 1912); and from the Pittsburgh district to eastern points, 3,304,980 short tons (against 3,294,656 tons in 1912).

The author is indebted to Lieut. Col. Francis R. Shunk, Corps of Engineers, U. S. Army, for the statement of the movement of coal through the locks of Monongahela River and at Davis Island Dam, and to the following railroad officials for the rail shipments from which the foregoing figures and the following table have been compiled: Messrs. R. H. Large, general coal freight agent, Pennsylvania Railroad Co., Philadelphia; W. L. Cromlish, coal and coke agent, Baltimore & Ohio Railroad, Pittsburgh; J. C. Venning, general ore and coal agent, Pennsylvania lines west of Pittsburgh; J. B. Nessle, general freight agent, Pittsburgh & Lake Erie Railroad, Pittsburgh; J. B. Safford, superintendent, Pittsburgh, Chartiers & Youghiogheny Railway, Pittsburgh; S. B. Woodside, general freight agent, Wabash-Pittsburgh Terminal & Westside Belt Railway, Pittsburgh.

The rail and water shipments to and from the Pittsburgh district during the last six years have been as follows:

Movement of coal to and through Pittsburgh, 1908–1913, in short tons, showing totals by rail and water.

Destination.	1908	1909	1910	1911	1912	1913
By rail:						
To Pittsburgh district	3,494,905	4,654,249	6,139,959	5,142,412	7,778,450	8,203,091
To west of Pittsburgh	18,970,848	18,981,995	a22,683,276	a22,474,289	24,086,001	26,044,234
Total by rail	22,465,753	23,636,244	28,823,235	27,616,701	31,864,451	34,247,325
By Monongahela River locks:						
To Pittsburgh district	6,435,851	9,737,505	9,460,695	9,207,232	9,943,333	10,335,585
To west of Pittsburgh	1,742,339	2,463,385	1,770,305	2,816,975	1,993,350	2,589,335
Total by water	8,178,190	12,200,890	11,231,000	12,024,207	11,936,683	12,924,920
Total shipments	30,643,943	35,837,134	40,054,235	39,640,908	43,801,134	47,142,245

a Includes a small quantity of coal sent to Lake Erie points.

Movement of coal to and through Pittsburgh, 1908–1913, in short tons, showing totals to Pittsburgh district and west of Pittsburgh.

Destination.	1908	1909	1910	1911	1912	1913
To Pittsburgh district:						
By rail	3,494,905	4,654,249	6,139,959	5,142,412	7,778,450	8,203,091
By water	6,435,851	9,737,505	9,460,695	9,207,232	9,943,333	10,335,585
Total to Pittsburgh district	9,930,756	14,391,754	15,600,654	14,349,644	17,721,783	18,538,676
To west of Pittsburgh:						
By rail	18,970,848	18,981,995	22,683,276	22,474,289	24,086,001	26,044,234
By water	1,742,339	2,463,385	1,770,305	2,816,975	1,993,350	2,589,335
Total to west of Pittsburgh	20,713,187	21,445,380	24,453,581	25,291,264	26,079,351	28,633,569
Total shipments to Pittsburgh and points west	30,643,943	35,837,134	40,054,235	39,640,908	43,801,134	47,172,245
Shipments, all rail, to points east of Pittsburgh	11,666,160	11,300,162	10,781,544	13,169,866	15,349,045	17,127,692

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BUFFALO, N. Y.

By JOHN W. CHAMBERLIN, trade journal correspondent.

There was a decided increase in practically all branches of the Buffalo coal trade during the first part of 1913, though as the close of the year approached it was seen that the movement was in great part artificial. The spectacle of heavy shipments of both anthracite and bituminous during the hot months, when the movement is commonly light, so inspired the operators, jobbers, and shipping agents that they called for cars between the mines and the city often far beyond the capacity of the railroads to supply them.

The consumer appeared to enter fully into the craze and readily paid the full circular prices for bituminous coal and coke as well as for anthracite. There was often a dollar or more premium paid for "independent" anthracite, which trade was and still is more active than formerly. As the fall season came on, when the trade should increase, it declined and continued to do so until the end of the year, leaving every member of the trade wondering at the odd reversal.

The increase of anthracite shipments by Lake from this port, from 3,665,717 long tons in 1912 to 4,657,331 tons in 1913, is a fair indication of the movement. These are the only figures to be had that are strictly dependable, those furnished by the customhouse being mostly cargo estimates. On this basis it is safe to estimate that the anthracite movement to the city increased 1,000,000 tons over 1912, and that of bituminous coal, 500,000 tons, which makes, speaking moderately, a total of 8,500,000 tons of bituminous and 8,000,000 tons of anthracite. City consumption does not exceed 450,000 tons of anthracite and something like half of the bituminous coal received, the rest going east, north, and west (bituminous) by rail, and north and west (anthracite) by Lake and rail.

It is easy to predict that the movement of both anthracite and bituminous coal in this direction in 1914 will be considerably less than it was in 1913. In fact, there has since the opening of 1914 been every evidence of a heavy overstock of both in practically every locality that depends on this market for its coal, besides which the local consumption, at least of bituminous coal, has fallen off pretty generally and is not likely to recover within the current year.

At the same time the importance of Buffalo as a sales and reshipping center continues in spite of dull trade, though the territory covered has not materially enlarged. The enlargement of the Welland Canal, on which work has already begun, will modify sales somewhat, but in what direction or amount is not to be stated now.

Though not in a mining State, Buffalo has 10 firms engaged in mining bituminous coal, which last year produced 6,525,000 tons of coal, 9 of the operations being in the Allegheny Valley and vicinity, in Pennsylvania, and 1 in Iowa. There is a general effort to increase this output from year to year, but only the Shawmut company gives promise of material progress, it having outlined an extensive new district adjacent to one opened a short time ago.

Transportation and handling facilities remain unchanged, with the exception of a second car ferry across Lake Ontario from Charlotte, to be built this year. Other new car-ferry projects on Lakes Erie and Ontario have not materialized.

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The increase in exports to Canada continues, as shown by the following table, though the Canadian trade at the close of 1913 and since has been exceedingly dull.

Export of coal and coke from Buffalo to Canada, 1907–1913, in long tons.

Year.	Anthracite.	Bituminous.	Coke.	Total.
1907	809,192	2,036,914	204,821	3,050,947
1908	786,063	1,726,332	213,712	2,726,107
1909	800,741	1,748,759	350,085	2,899,585
1910	931,378	2,014,762	420,805	3,366,945
1911	1,695,035	2,620,727	416,069	4,231,831
1912	1,234,564	2,609,702	423,524	4,267,790
1913	1,615,176	2,906,682	475,417	4,997,275

There was no change in rail freights during the year, and the trade is somewhat unsettled on account of it, as the idea prevails that the general changes contemplated are not to include coal rates. The rates to Buffalo for 1913 were $2 from the anthracite mines, $1.25 for bituminous coal from the Pittsburgh district, $1.10 from the Allegheny Valley, $1.85 for Connellsville coke, and $1.75 by rail from Buffalo to Chicago. The Lake rate, for a long time 40 cents to leading Lake Michigan ports and 30 cents to Lake Superior, has in 1914 been made 30 cents generally, except to minor ports.

CINCINNATI, OHIO.

[From the annual report of W. C. Culkins, executive secretary and superintendent of the Cincinnati Chamber of Commerce.]

The coal trade of Cincinnati in 1913 presented a number of unusual features. It opened with an abundance of coal arriving from the mines by rail and river. Contract prices by operators and sales agencies went on smoothly up to the first of April, the usual contracting time. One of the unique occurrences of the first of April was that contract prices were advanced sharply over those in any years in the history of the trade, and so promising were the prospects that there were no murmurs on the part of buyers. The railroads were taxed to their utmost to move the big consignments of coal in addition to other merchandise transportation demanded.

The floods of March and April changed the aspect of the case to a greater stringency of cars and greater difficulties of transportation. Prices were advanced monthly throughout the year, largely because of the shortage in transportation, and in August the highest prices were reached for every grade and for every division of the production of the mines. Demand was strong up to the latter part of November, when it began to recede, as far as domestic consumption was concerned, solely on account of the weather. The demand for manufacturing purposes continued strong up to the holidays, when it fell off, and the close of the year saw a practically demoralized market with an overproduction of coal and a disposition on the part of some of the trade to force the product into an already more than abundant supply.

The records of the Chamber of Commerce show that notwithstanding flood, fire, and the exceptionally warm weather, the business of 1913 was somewhat in excess of that of 1912, and as prices were much

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better, the year was more profitable than usual to all interested in the trade.

The annual receipts of coal, in short tons, at Cincinnati, according to reports of gagers, private returns, and records of the Chamber of Commerce, for the last five years, have been as follows:

Receipts of coal at Cincinnati, 1909–1913, in short tons.

Year.	By river.			By rail.	
	Pittsburgh.	Kanawha.	Other kinds.	Receipts.	Anthracite.
1909	839,952	1,000,336	1,952	3,053,760	18,840
1910	514,140	949,160	1,460	4,384,240	13,480
1911	729,748	1,536,551	.....	5,212,701	6,280
1912	501,640	1,313,981	.....	6,017,893	8,640
1913	428,737	1,507,257	.....	6,210,832	13,689

Total annual receipts, by river and by rail, and aggregate receipts, with total annual shipments, by river and by rail, and aggregate shipments, for five years:

Movements of coal at Cincinnati, 1909–1913, in short tons.

Year.	Receipts.			Shipments.		
	By river.	By rail.	Aggregate.	By river.	By rail.	Aggregate.
1909	1,842,240	3,053,760	4,896,000	269,080	2,528,440	2,797,520
1910	1,464,760	4,384,240	5,849,000	170,240	4,036,800	4,207,040
1911	2,266,299	5,212,701	7,479,000	246,076	4,077,342	4,323,418
1912	1,815,621	6,026,533	7,842,154	279,842	4,396,859	4,676,701
1913	1,935,994	6,224,521	8,160,515	357,313	4,341,462	4,698,775

CLEVELAND, OHIO.

The total coal and coke receipts at Cleveland, as reported by Mr. Munson A. Havens, secretary of the Cleveland Chamber of Commerce, increased nearly 1,240,000 short tons over 1912, which held the record up to the close of that year. Three-fourths of this increased business was in the local consumption and about one-fourth represented the increase in the shipments through Cleveland by Lake and rail to other points. The total receipts in 1913 were 9,817,157 short tons, against 8,577,834 tons in 1912. All of the increase was in the receipts of bituminous coal which showed a gain of nearly 2,150,000 tons, from 6,673,940 tons in 1912 to 8,822,355 tons in 1913. Anthracite receipts fell off slightly, from 150,647 tons to 140,227 tons. The coke receipts were more than cut in half, from 1,753,247 short tons to 854,575 tons. The shipments of coke to other points in 1913 were 200,000 tons less than in 1912, these figures being respectively 288,238 tons and 85,303 tons. The quantity of coal manufactured in Cleveland in 1913 was slightly less than in the preceding year so that the total consumption of coke in that city was about 700,000 tons less than in 1912. The consumption of bituminous coal on the other hand shows an increase of about 1,660,000 short tons and indicates that the manufacturing enterprises using bituminous coal for fuel were more active than those dependent upon coke.

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The total receipts of anthracite and bituminous coal and coke were 9,817,157 short tons, the shipments were 4,986,302 tons, and the local consumption 4,830,855 tons. The last figure compared with the local consumption of 1912, which was 3,921,307 short tons, shows a considerable gain.

The coal and coke receipts and shipments at Cleveland, Ohio, for the last five years are shown in the following tables:

Coal and coke receipts and shipments at Cleveland, Ohio, 1909–1913, in short tons.

RECEIPTS.

Kind.	1909	1910	1911	1912	1913
Bituminous	6,264,998	7,097,170	6,242,910	6,673,940	8,822,355
Anthracite	363,162	400,425	168,208	150,647	140,227
Coke	1,034,649	937,714	911,477	1,753,247	854,575
Total	7,662,809	8,435,309	7,322,595	8,577,834	9,817,157

SHIPMENTS.

Anthracite by rail	25,383	18,020	.....	.....	46,409
Bituminous by rail	122,814	383,408	.....	118,623	176,665
Bituminous by lake	4,602,275	5,023,368	3,108,741	4,249,666	4,677,925
Coke by rail	102,375	197,784	273,313	288,238	85,303
Total	4,852,847	5,622,580	3,382,054	4,656,527	4,986,302

Total coal and coke receipts and shipments, with local consumption, at Cleveland, Ohio, 1909–1913, in short tons.

Year.	Receipts.	Shipments.	Local consumption.
1909	7,662,809	4,852,847	2,809,962
1910	8,435,309	5,622,508	2,812,801
1911	7,322,595	3,382,054	3,940,541
1912	8,577,834	4,656,527	3,921,307
1913	9,817,157	4,986,302	4,830,855

MILWAUKEE, WIS.

[From the annual report of H. A. Plumb, secretary of the Milwaukee Chamber of Commerce.]

A new record was established in the receipts of coal at Milwaukee in 1913, the quantity arriving having reached a total of 5,860,263 short tons. These receipts include arrivals both by Lake and rail, the Lake receipts amounting to 5,228,770 tons and the rail receipts to 631,493 tons. Both of these figures exceeded any others in the history of the city. It should be remembered that the receipts by rail include the coal reaching Milwaukee over the car-ferry routes. This item in 1913 amounted to 322,708 short tons, which was practically identical with the figures for 1912, when the car-ferry receipt were 323,705 tons. There were altogether 809 cargoes of coal so arriving at the port of Milwaukee during the open season of navigation in 1913. The average cargoes were 6,462 tons, of which the bituminous cargoes averaged 6,826 tons and the anthracite 5,441 tons. As indicative of the larger bunker capacity employed in 1913 in carrying coal to Milwaukee, these averages compare with 6,647 tons as the

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average cargo of bituminous coal and with 5,077 tons as the average of anthracite in 1912. In 1913 there were 129 cargoes of over 10,000 tons each, compared with 73 equivalent cargoes in 1912, and the number of cargoes in excess of 11,000 tons increased from 13 in 1912 to 28 in 1913.

Coal is received at Milwaukee by 28 plants, 4 of which are private firms not in the retail trade. The 28 plants have an unloading capacity of 100,000 tons in 10 hours. The freight rates to Milwaukee during 1913 were 5 cents higher than in 1912, except in December. The rates to Milwaukee were from 5 to 10 cents less than to Chicago and 5 cents more than to Duluth and Superior.

The receipts of coal at and shipments from Milwaukee during the last five years, and the total receipts for a series of years since 1865, are shown in the following tables:

Receipts of coal at Milwaukee, Wis., 1909–1913, in short tons.

Source.	1909	1910	1911	1912	1913
By lake from—					
Buffalo	778,392	810,409	909,080	834,131	1,028,491
Erie	80,980	82,072	90,342	367,527	153,602
Oswego	56,588	68,983	65,166	64,213	79,150
Cleveland	382,828	436,057	219,852	357,232	570,599
Ashtabula	212,314	520,376	446,330	242,297	486,739
Lorain	610,444	671,656	848,687	766,897	722,098
Sandusky	393,869	388,467	369,601	532,065	599,752
Toledo	1,057,076	1,311,786	1,453,631	1,180,596	1,228,153
Fairport	108,210	61,737	107,803	48,037	27,853
Huron, Ohio	26,015	86,046	64,780	144,966	129,068
Other ports	115,358	173,743	30,150	44,727	203,265
Total Lake	3,822,074	4,611,332	4,605,422	4,582,688	5,228,770
By railroad	[a] 353,948	[b] 449,869	[c] 409,489	589,569	631,493
Total receipts	4,176,022	5,061,201	5,014,911	5,172,257	5,860,263

[a] Including 205,669 tons by car ferry.
[b] Including 327,415 tons by car ferry.
[c] Including 265,572 tons by car ferry.

Shipments of coal from Milwaukee, Wis., 1909–1913, in short tons.

Shipped by—	1909	1910	1911	1912	1913
Chicago, Milwaukee & St. Paul Ry	776,010	1,019,330	765,980	248,768	394,734
Chicago & North Western Ry	483,250	530,010	543,840	577,225	495,100
Wisconsin Central Ry.[a]	123,500	139,435	119,135	129,607	104,003
Lake		360	60	178	6,762
Total	1,382,760	1,689,135	1,429,015	955,778	1,000,599

[a] The Wisconsin Central Railway is now part of the "Soo line."

Receipts of coal by lake at Milwaukee, Wis., 1909–1913, by kinds, in short tons.

Kind.	1909	1910	1911	1912	1913
Anthracite	834,980	930,472	1,013,907	973,388	1,153,406
Bituminous	2,987,094	3,680,860	3,591,515	3,609,300	4,075,364
Total	3,822,074	4,611,332	4,605,422	4,582,688	5,228,770

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Receipts of coal at Milwaukee, Wis., by lake and rail, in 1865, 1870, 1880, 1890, 1900, 1905, and annually from 1910 to 1913, in short tons.

1865	36,369	1905	3,157,464
1870	122,865	1910	5,061,201
1880	368,568	1911	5,014,911
1890	999,657	1912	5,172,257
1900	1,808,593	1913	5,860,263

Lake freights on coal from Buffalo to principal upper Lake ports during the season of 1913, as compared with those of 1912, were as follows:

Freight rates per ton on coal from Buffalo to principal upper lake ports, 1912 and 1913, by months.

Month.	To Milwaukee.		To Chicago.				To Duluth.	
			North Branch.		South Branch.			
	1912	1913	1912	1913	1912	1913	1912	1913
March	$0.30	$0.35	$0.35	$0.40	$0.40	$0.45	$0.30	$0.30
April	.30	.35	.35	.40	.40	45	.30	.30
May	.30	.35	.35	.40	.40	.45	.30	.30
June	.30	.35	.35	.40	.40	.45	.30	.30
July	.30	.35	.35	.40	.40	.45	.30	.30
August	.30	.35	.35	.40	40	.45	.30	.30
September	.30	.35	.35	.40	.40	.45	.30	.30
October	.30	.35	.35	.40	.40	.45	.30	.30
November	.30	.75	.35	.40	.40	.45	.30	.30
December	1.00	.....	1.00	.75	1.00	.75	1.00	1.00

ST. LOUIS, MO.

According to statistics furnished by Mr. William F. Saunders, secretary and general manager of the Business Men's League of St. Louis, there was a decrease of a little more than 3 per cent in the consumption of bituminous coal in 1913, as compared with the high record of the city in 1912; the statistics of anthracite and coke were practically the same in both years. The receipts of bituminous coal decreased from 8,942,872 short tons in 1912 to 8,651,156 tons, the difference being 291,716 tons. The anthracite receipts were 274,423 tons in 1913, as compared with 277,683 tons, a decrease of 3,260 tons. The receipts of coke in each of the last four years have varied barely 2,000 tons, ranging from 190,370 tons in 1912 to 192,425 tons in 1911. In 1913 they amounted to 190,857 tons. In the coal trade of St. Louis receipts and local consumption are practically synonymous terms, as all of the coal entering the city is consumed there or in the immediate suburbs.

St. Louis is favorably situated for securing cheap fuel, being within a short distance of the coal fields of southwestern Illinois.

The receipts of coal and coke at St. Louis during the last six years, and the high, low, and closing prices in 1912 and 1913, are shown in the following tables.

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Coal and coke receipts at St. Louis, Mo., 1908–1913, in short tons.

Year.	Bituminous.	Anthracite.	Coke.	Year.	Bituminous.	Anthracite.	Coke.
1908	7,129,055	236,036	357,016	1911	7,798,309	487,030	192,425
1909	7,418,268	236,040	171,570	1912	8,942,872	277,683	190,370
1910	7,945,680	289,463	191,190	1913	8,651,156	274,423	190,857

Coal prices at St. Louis, Mo., during 1912 and 1913, in short tons.

Kind.	1912			1913		
	Highest.	Lowest.	Closing.	Highest.	Lowest.	Closing.
Standard Illinois lump coal	$2.02	$1.27	$1.62	$1.82	$1.32	$1.62
High-grade Illinois lump coal	2.92	1.67	2.22	2.67	1.67	2.32
Anthracite, large	6.95	6.45	6.95	6.95	6.45	6.95
Anthracite, small	7.20	6.70	7.20	7.20	6.70	7.20
Connellsville coke	6.80	5.30	6.80	5.40	5.25	5.25
New River coke	6.80	5.30	6.80	5.40	5.25	5.25
Kentucky coke	4.75	3.25	4.75	4.00	3.60	3.60
Gas coke	5.00	4.25	5.00	4.85	4.30	4.75

SAN FRANCISCO, CAL.

In San Francisco, as in other cities of the Pacific coast, the use of petroleum for steam purposes by railroads and manufacturers has largely supplanted coal, which is at the present time confined almost entirely to domestic consumption. The total quantity of coal consumed in San Francisco and the neighboring cities on the eastern shore of San Francisco Bay in 1913 was apparently about 525,000 short tons. The three railroads entering California—the Southern Pacific, the Western Pacific, and the Atchison, Topeka & Santa Fe—carried into the State in 1913 (including the coal used by themselves) a total of 363,123 tons, chiefly from New Mexico, Utah, and Wyoming, and 75,743 tons of it went to San Francisco. The receipts of domestic coal by water at San Francisco amounted to 193,962 long tons (207,236 short tons), of which 126,668 long tons (141,868 short tons) were from eastern States for use chiefly in United States naval vessels in Pacific waters. The imports, principally from Australia, Japan, and British Columbia, amounted in 1913 to 217,070 long tons (243,148 short tons). Labor troubles in the British Columbian mines were responsible for a heavy decrease in receipts from that region, which were partly made up by larger imports from Japan. The total imports, however, showed considerable decrease in 1913 as in 1912, owing to the larger use of petroleum fuel in the city and State. Receipts of coal from Australia and Japan depend principally upon the exports of wheat from California, vessels carrying wheat bringing return cargoes of coal for ballast.

The statistics showing the shipments of coal by rail into San Francisco and other cities in California in 1913 have been furnished through the courtesy of Messrs. W. G. Barnwell, assistant freight traffic manager, Atchison, Topeka & Santa Fe Railway at San Francisco; G. W. Luce, freight traffic manager, Southern Pacific Co., at San Francisco; and J. T. Hendricks, freight traffic manager, Western Pacific Railway, at San Francisco. The statistics of re-

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ceipts of coal by water from Washington and Oregon have been furnished by Mr. L. M. King, secretary, San Francisco Chamber of Commerce; and the imports of foreign coals, by the Bureau of Foreign and Domestic Commerce, Department of Commerce.

It is estimated that the total consumption of California oil for fuel, including that used in the manufacture of gas, was 63,000,000 barrels in 1913, equivalent, approximately, to 18,000,000 tons of coal, or about 22 times as much as the coal consumed within the State. The total consumption in 1913, estimated from the rail and water receipts, was about 813,500 tons. The receipts of coke, chiefly from Great Britain and Germany, amounted in 1913 to 31,222 short tons, a decrease from 39,116 tons in 1912.

Sources of coal consumed in California, 1907–1913, in long tons.

[Includes arrivals by water only at port of San Francisco.]

Sources.	1907	1908	1909	1910	1911	1912	1913
British Columbia	243,677	165,204	188,125	157,489	207,203	181,138	43,017
Australia	142,924	452,819	68,086	115,179	198,730	92,033	82,694
Great Britain	31,359	21,805	3,105	.....	2,639	1,429	420
China	.....	.....	.....	.....	6,170	822	801
Japan	33,598	58,170	546	38,817	279	1,638	89,888
Panama	.....	.....	.....	.....	.....	.....	250
Oregon	32,645	22,205	24,125	23,293	7,439	1,200	193,962
Washington	85,738	69,947	16,940	50,342	57,298	49,829	
Eastern	34,333	188,110	69,696	101,265	80,338	122,090	
Total	604,274	978,260	370,623	486,385	560,096	450,179	411,032

PRODUCTION OF COAL BY STATES.

ALABAMA.

Total production in 1913, 17,678,522 short tons; spot value. $23,083,724.

The increase in coal production in Alabama in 1913 as compared with 1912 was 1,577,922 short tons, or 9.8 per cent, in quantity and $2,254,472, or 10.8 per cent, in value. The average value per ton advanced from $1.29 to $1.31. The increased production in 1913 was due to several causes. During a part of 1912 some of the larger companies were in the hands of receivers and this condition cut down the possible output for that year. The production was further restricted by the burning of the tipple at one of the large mines. The tipple was not rebuilt until the early part of 1913. Several new mines were opened in 1913 and these have been furnishing a gradually increasing output. Some of the older mines have added improvements and extended their workings to provide for an increased tonnage. Labor conditions were much better in 1913 than in either 1912 or 1911, for, although in some districts there was a scarcity rather than a surplus, other districts reported a better labor supply, miners having been recruited from other lines of employment. Car shortage was less acute than in recent years prior to 1913, as some of the large coal-carrying roads have added materially to their facilities for handling the output. The increased tonnage went principally to points outside the State, as the demand for manufacturing, transportation, and domestic consumption within the State was not above

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normal. The most notable feature in the trade was the increased bunker requirements on the Gulf coast and larger shipments of coke to western points. The relations between operators and mine workers were generally harmonious and increased wages were put in force in February. Earnings by miners and mine laborers in 1913 are said to have been higher than ever before in the history of coal mining in Alabama. Improved sanitary and living conditions put into effect by many companies added to the general betterment.

The average tonnage per man for 1913 showed an increase over 1912 from 712 to 720, but there was a slight falling off in the average output per man per day from 2.91 to 2.82. The former was due to the larger number of days worked—255 in 1913 against 245 in 1912, and the latter partly to the amount of development work in progress during 1913 and partly to the larger number of new recruits. The number of men employed in 1913 was 24,552, against 22,613 in 1912.

The production by the use of machines increased from 3,742,549 short tons in 1912 to 4,124,301 tons in 1913, the percentage to the total output being about the same in both years, 23.2 per cent in 1912 and 23.3 per cent in 1913. The number of machines increased from 353 to 377. Of the latter 249 were punchers, 42 chain breast, 20 long wall, and 66 short wall. It is unfortunate to be obliged to record a marked increase in the quantity and percentage of coal shot off the solid. In 1912 the quantity of powder-mined coal reported was 5,658,457, or 35.1 per cent of the total; in 1913 it was 7,052,234 tons, or 39.9 per cent. The hand-mined coal decreased from 6,658,732 tons, or 41.4 per cent, in 1912. to 6,315,787 tons, or 35.7 per cent, in 1913.

The statistics of fatal accidents compiled by the Bureau of Mines show that there were 124 men killed in the coal-mining operations of Alabama in 1913, all but 1 underground. More than half of the deaths, 68 in all, were due to falls of roof and coal, 27 to gas and dust explosions (including suffocations by mine gases), and 19 to mine cars and locomotives. In 1912 there were 121 fatal accidents in Alabama coal mines. The death rate per thousand in 1913 was 5 against 5.4 in 1912, and the number of tons mined for each life lost was 142,569 against 133,063.

The total time lost by strikes in 1913 was 27,041 days, 1,048 men being idle for an average of 26 days.

Nearly one-half of the coal mined in Alabama in 1913 was washed before being marketed or used in the manufacture of coke. The quantity washed was 8,149,082 tons, yielding 7,210,588 tons of cleaned coal and 938,494 tons of refuse. The difference of 1.3 per cent between the production as reported to the Geological Survey and to the State mine inspector is probably due to the inclusion in the reports to the latter of some of the refuse, and its omission in the reports to the Survey. The quantity of refuse actually reported to the Survey as removed at the mines and deducted from the gross tonnage was more than twice the difference between the Federal and State figures.

The statistics of production of coal in Alabama in 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

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Coal production of Alabama in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bibb	1,662,198	9,823	109,314	.....	1,781,335	$2,621,682	$1.47	272	2,948
Blount	143,603	1,139	1,600	.....	146,342	181,036	1.24	211	282
Etowah	166,366	3,067	1,875	.....	171,308	249,749	1.46	265	260
Jefferson	6,168,715	81,368	339,211	1,585,555	8,174,849	10,433,728	1.28	251	10,922
St. Clair	722,276	2,456	25,021	.....	749,753	959,219	1.28	291	725
Shelby	463,788	3,501	29,660	.....	496,949	872,501	1.76	250	878
Tuscaloosa	631,114	12,038	48,863	188,952	880,967	1,091,882	1.24	239	1,220
Walker	3,271,284	32,030	102,681	141,967	3,547,962	4,158,094	1.17	211	5,079
Winston	18,550	105	75	.....	18,730	27,793	1.48	220	57
Other counties [a] and small mines	124,627	2,059	5,719	.....	132,405	233,568	1.76	229	242
Total	13,372,521	147,586	664,019	1,916,474	16,100,600	20,829,252	1.29	245	22,613

1913.

Bibb	1,802,243	9,214	99,569	.....	1,911,026	$2,979,240	$1.56	274	3,158
Blount	174,580	2,758	1,620	.....	178,958	236,448	1.32	203	354
Etowah	135,815	725	1,252	.....	137,792	171,600	1.25	256	209
Jefferson	7,149,844	83,353	412,891	1,382,746	9,028,834	11,790,737	1.31	266	11,643
St. Clair	861,579	2,909	25,891	.....	890,379	1,150,457	1.29	277	798
Shelby	457,313	4,469	35,787	.....	497,569	862,783	1.73	257	850
Tuscaloosa	699,690	13,891	68,836	134,888	917,305	1,172,227	1.28	271	1,183
Walker	3,671,708	42,809	101,760	150,986	3,967,263	4,481,373	1.13	223	6,031
Winston	24,841	60	50	.....	24,951	36,724	1.47	228	67
Other counties [a]	116,423	2,162	5,030	.....	123,615	200,059	1.62	233	259
Small mines	.....	830	.....	.....	830	2,076	2.50	.....	.....
Total	15,094,036	163,180	752,686	1,668,620	17,678,522	23,083,724	1.31	255	24,552

[a] Cullman, Jackson, and Marion.

In the following table is presented a statement of the production of coal in Alabama, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912:

Coal production of Alabama, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Bibb	1,338,243	1,580,564	1,633,197	1,781,335	1,911,026	+ 129,691
Blount, Cullman	[a] 186,261	[a] 235,456	[a] 210,070	[a] 276,429	[a] 300,092	+ 23,663
Etowah	46,194	172,465	255,860	171,308	137,792	− 33,516
Jefferson	7,176,922	8,298,702	7,776,390	8,174,849	9,028,834	+ 853,985
St. Clair	354,005	428,409	529,211	749,753	890,379	+ 140,626
Shelby	524,925	488,141	463,089	496,949	497,569	+ 620
Tuscaloosa	1,006,989	1,081,219	1,031,658	880,967	917,305	+ 36,338
Walker	2,973,776	3,788,479	3,103,595	3,547,962	3,967,263	+ 419,301
Winston	32,278	16,442	16,424	18,730	24,951	+ 6,221
Other counties and small mines	63,857	21,585	1,927	2,318	3,311	+ 993
Total	13,703,450	16,111,462	15,021,421	16,100,600	17,678,522	+ 1,577,922
Total value	$16,306,236	$20,236,853	$19,079,949	$20,829,252	$23,083,724	+$2,254,472

[a] Includes production of Marion County.

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The great Appalachian coal region which furnishes over two-thirds of the coal production of the United States and which extends from Ohio and Pennsylvania on the north in a gradually narrowing belt through eastern Kentucky and Tennessee has its southern terminus in a considerably broadened area that occupies a large part of the northern half of Alabama. The coal-bearing formations of Alabama underlie about 8,400 square miles and are divided into four distinct basins, the Coosa, the Cahaba, and the Warrior, named from the rivers which drain them, and the Plateau, which includes Blount, Lookout, and Sand or Raccoon Mountains. By far the most important basin in area and in production is the Warrior, which includes all of Walker County, most of Jefferson, Tuscaloosa, and Fayette counties, and smaller parts of Blount, Cullman, Winston, and Marion counties. The area known to contain coal is approximately 4,000 square miles, or one-half the total coal area of the State, and contributes about 80 per cent of the total production.

There are several distinct coal groups in the basin, the most important of which are the Brookwood, the Pratt, and the Mary Lee, designated by the names of their principal beds. The Mary Lee group includes the Blue Creek, the Jagger, and the Newcastle beds, most of which are mined in places. The Brookwood, the Pratt, and the Mary Lee produce most of the coking coal mined in the State, and more than half of all of the coal mined in the district.

The Cahaba Basin, second in importance, is a long narrow syncline, 68 miles long and about 6 miles wide, southeast of the Warrior, and occupies parts of St. Clair, Jefferson, Shelby, and Bibb counties. There are many workable beds, and the total quantity of coal in the basin is large. The production is something over 10 per cent of the total for the State.

The Coosa Basin is a deep syncline east of the Cahaba and parallel with it, extending across Shelby and St. Clair counties. It is also long and narrow, 60 miles long by 6 miles wide. It has not been thoroughly explored, but in different parts of the area from two to twelve beds, 3 or more feet in thickness, have been reported.

The Plateau field embraces parts of Blount, Etowah, Dekalb, Cherokee, Marshall, and Jackson counties, and although it has an area underlain by coal four times that of the Cahaba and the Coosa combined, the resources in Alabama are comparatively small. There are four to six beds locally workable.

So far as known, the earliest record of the existence of coal in Alabama was made in 1834. The first statement of production in the State is contained in the United States census report for 1840, in which year the production is given as 946 tons. The census report for 1850 does not mention any coal production for the State, and the next authentic record is contained in the census statistics of 1860, when Alabama is credited with an output of 10,200 short tons. The mines of Alabama were probably worked to a considerable extent during the Civil War, but there are no records of the actual production until 1870, for which year the United States census reports a production of 11,000 tons. Ten years later the production had increased to 323,972 short tons, but the development of the present great industry really began in 1881 and 1882, when attention was directed to the large iron deposits near the city of Birmingham, and

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thus the great "boom" of that city and vicinity was inaugurated. By 1885 the coal production of the State had increased to nearly 2,500,000 tons. Then followed a period of relapse and liquidation, which lasted two years, after which business settled down to a conservative and rational basis and has since developed steadily. In 1902 the coal production of the State reached a total of more than 10,000,000 tons, and reached the maximum of 17,678,522 tons in 1913.

The statistics of production in Alabama from 1840 to the close of 1913 are shown in the following table:

Production of coal in Alabama from 1840 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	946	1859	9,000	1878	224,000	1897	5,893,770
1841	1,000	1860	10,200	1879	280,000	1898	6,535,283
1842	1,000	1861	10,000	1880	323,972	1899	7,593,416
1843	1,200	1862	12,500	1881	420,000	1900	8,394,275
1844	1,200	1863	15,000	1882	896,000	1901	9,099,052
1845	1,500	1864	15,000	1883	1,568,000	1902	10,354,570
1846	1,500	1865	12,000	1884	2,240,000	1903	11,654,324
1847	2,000	1866	12,000	1885	2,492,000	1904	11,262,046
1848	2,000	1867	10,000	1886	1,800,000	1905	11,866,069
1849	2,500	1868	10,000	1887	1,950,000	1906	13,107,963
1850	2,500	1869	10,000	1888	2,900,000	1907	14,250,454
1851	3,000	1870	11,000	1889	3,572,983	1908	11,604,593
1852	3,000	1871	15,000	1890	4,090,409	1909	13,703,450
1853	4,000	1872	16,800	1891	4,759,781	1910	16,111,462
1854	4,500	1873	44,800	1892	5,529,312	1911	15,021,421
1855	6,000	1874	50,400	1893	5,136,935	1912	16,100,600
1856	6,800	1875	67,200	1894	4,397,178	1913	17,678,522
1857	8,000	1876	112,000	1895	5,693,775		
1858	8,500	1877	196,000	1896	5,748,697	Total	254,954,358

ALASKA.

The total production of coal in Alaska in 1913 was 2,300 tons, valued at $13,800. This does not include about 1,000 tons of coal taken from the Matanuska field for official test by the Navy Department. This coal was mined during the summer under the supervision of the Bureau of Mines and was sledded to Knik during the winter. In the previous year, 1912, about 600 tons were mined from one of the Cunningham claims in the Bering River field and tested on a warship at Annapolis, but the coal was found unsuited for naval vessels. This coal was not included in the production for that year. Most of the small production of commercial coal in 1913 was from the Whorf mine at Port Graham, patented in 1913, and the only coal mine in Alaska to which patent has been issued. The mine has been opened on about 65 acres and supplies a local market with a lignitic product. All of the other coal mined was lignite for individual use.

The following table shows the annual coal production of Alaska since 1897, and an estimate of the output between 1888 and 1896. A little coal was mined prior to 1884 by the crews of vessels that ran short of fuel, but it probably did not aggregate more than a few hundred tons. The total output of coal prior to 1889, including that mined by the Russians, was probably less than 10,000 tons.

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Production of coal in Alaska, 1888–1913, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1888–1896	6,000	$84,000	1906	5,541	$17,974
1897	2,000	28,000	1907	10,139	53,600
1898	1,000	14,000	1908	3,107	14,810
1899	1,200	16,800	1909	2,800	12,300
1900	1,200	16,800	1910	1,000	15,000
1901	1,300	15,600	1911	900	7,200
1902	2,212	19,048	1912	355	2,840
1903	1,447	9,782	1913	2,300	13,800
1904	1,694	7,225			
1905	3,774	13,250	Total	47,969	362,029

NOTE.—The production for 1888–1896 is estimated on the best data obtainable. The figures for 1897 to 1913 are based for the most part on data supplied by operators.

The consumption of coal in Alaska since 1899 has been as follows:

Coal consumption of Alaska, by sources, 1899 to 1913, in short tons.

Year.	Imported from States, chiefly from Washington.		Produced in Alaska, chiefly subbituminous and lignite.[b]	Total domestic.[b]	Total foreign coal, chiefly bituminous from British Columbia.[c]	Total coal consumed.
	Bituminous.	Anthracite.				
1899	[a] 10,000	.....	1,200	11,200	50,120	61,320
1900	15,048	.....	1,200	16,248	56,623	72,871
1901	[a] 24,000	.....	1,300	25,300	77,674	102,974
1902	[a] 40,000	.....	2,212	42,212	68,363	110,575
1903	64,625	1	1,447	66,073	60,605	126,678
1904	36,689	.....	1,694	38,383	76,815	115,198
1905	67,707	6	3,774	71,487	72,567	144,054
1906	68,960	533	5,541	75,034	47,590	122,624
1907	45,130	1,116	10,139	56,385	88,596	144,981
1908	23,402	491	3,107	27,000	72,831	99,831
1909	33,112	.....	2,800	35,912	74,316	110,228
1910	32,138	.....	1,000	33,138	73,904	107,042
1911	32,255	.....	900	33,155	88,573	121,728
1912	27,767	.....	355	28,122	59,804	87,926
1913	61,666	.....	2,300	63,966	60,600	124,566
Total	582,499	2,147	38,969	623,615	1,028,981	1,652,596

[a] Estimated. [b] By calendar years. [c] By fiscal years ending June 30.

While the coal consumption in Alaska remained nearly stationary, the use of fuel oil has very much increased. The Treadwell group of mines now uses California oil, as do many of the dredges at Nome, steamers running to Alaska and boats on Yukon River. The Copper River Railway is now partly equipped with oil-burning locomotives, and the Alaska Northern Railroad, when operated at all, uses a gasoline car. The Tanana Valley Railroad also runs a gasoline passenger coach. The following table indicates the increased use of oil-burning and gasoline engines in Alaska. This, of course, does not include the fuel oil used by coastwise steamers, which is estimated at 541,000 barrels, in 1913.

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Shipments of petroleum products to Alaska from other parts of the United States, 1905–1913, in gallons.

Year.	Crude.		Naphtha.		Illuminating.		Lubricating.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1905	2,715,386	$91,068	713,496	$109,921	627,391	$113,921	83,319	$31,660	$346,570
1906	2,688,100	38,409	580,978	100,694	568,033	109,964	83,992	32,854	281,921
1907	9,104,300	143,506	636,881	119,345	510,145	99,342	100,145	37,929	400,122
1908	11,891,375	176,483	939,424	147,104	566,598	102,567	94,542	36,423	462,577
1909	14,034,900	334,258	746,930	118,810	531,727	98,786	85,687	35,882	587,736
1910	18,835,670	477,673	788,154	136,569	626,972	95,483	104,512	38,625	748,350
1911	18,142,364	406,400	1,238,865	167,915	423,750	57,896	100,141	34,048	666,259
1912	15,523,555	309,804	2,736,739	344,739	672,176	100,722	154,565	60,949	816,214
1913	15,682,412	453,756	1,735,658	272,661	661,656	106,603	150,918	61,966	894,986

ARKANSAS.

Total production in 1913, 2,234,107 short tons; spot value, $3,923,701.

The coal production of Arkansas increased from 2,100,819 short tons, valued at $3,582,789 in 1912, to 2,234,107 tons, valued at $3,923,701 in 1913, a gain of 133,288 tons, or 6.34 per cent in quantity and of $340,912, or 9.52 per cent in value. The average value per ton advanced from $1.71 to $1.76. The increased production in 1913 is attributed chiefly to a larger railroad consumption caused by a decrease in the supply of fuel oil, but partly also to increased business. This was offset to some extent by decreased domestic consumption, particularly in Texas, due to an increased use of natural gas in that State. The prolonged drought in August and September also had an adverse influence upon coal production, as it cut down the wheat crop in Kansas and the cotton crop in Oklahoma and Texas. Transportation facilities were improved over those of previous years and a reduction in freight rates, put into effect in the latter part of the year, is expected to have a beneficial effect upon the industry by enabling larger quantities of coal to be shipped to the northwest, where Arkansas semianthracite has established a market and has already, to some extent, replaced West Virginia smokeless coal. The conditions at the close of 1913 presented a more hopeful outlook for the future than has obtained in Arkansas for several years. Complaint is still made of a short and unsatisfactory supply of labor. Operations at Hartford were interrupted for some time in 1913 by a controversy over the machine-mining scale, and a number of small strikes due to various causes occurred at Jenny Lind and Denning. The controversy over the machine-mining rate arose as the result of the introduction of a number of machines into a district for which no scale existed at the time. The effect of their use is exhibited in the production by an increase from 76,611 short tons of machine-mined coal in 1912 to 251,105 tons in 1913. It is also shown in a gratifying decrease in the quantity of coal shot off the solid—from 1,937,817 tons to 1,775,851 tons. In 1912 the coal shot off the solid represented a little more than 92 per cent of the total product; in 1913 it was 79.5 per cent. The number of machines in use in 1913 was 27, three times the number in use in

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1912. Four of the machines operated in 1913 were short wall and 23 were chain breast.

The number of men on strike for one cause or another in 1913 was 1,221, a little more than one-fourth of the total number employed, and the average number of working days lost by each man on strike was 27. The total number of employees increased from 4,536 in 1912 to 4,652 in 1913, and the average working time increased from 157 to 174 days. The average quantity of coal produced by each man employed was 2.76 tons per day and 480 tons during the year in 1913 against 2.95 and 463 tons, respectively, in 1912.

According to the Bureau of Mines, there were 12 fatal accidents in 1913—just double the number in 1912. Half of the fatalities in 1913 were due to falls of roof and coal and 2 to an explosion of dust. The death rate per thousand in 1913 was 2.58, and there were 186,176 tons of coal mined for each life lost. In 1912 the death rate was 1.3, and the quantity of coal mined for each life lost was 350,137 tons.

The statistics of production, by counties, for 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

Coal production of Arkansas in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Franklin	355,637	2,390	15,287	373,314	$609,453	$1.63	172	750
Johnson	184,110	3,391	4,825	192,326	441,226	2.29	105	698
Logan	12,622	2,500	150	15,272	40,203	2.63	156	44
Sebastian	1,388,037	5,467	60,624	1,454,128	2,301,904	1.58	164	2,869
Other counties [a] and small mines	56,416	1,363	8,000	65,779	190,003	2.89	200	175
Total	1,996,822	15,111	88,886	2,100,819	3,582,789	1.71	157	4,536

1913.

Franklin	331,539	1,730	13,413	346,682	$591,766	$1.71	178	657
Johnson	156,517	2,095	7,596	166,208	397,198	2.39	111	711
Sebastian	1,547,695	2,980	84,704	1,635,379	2,681,657	1.64	185	2,930
Other counties [b] and small mines	81,607	1,182	3,049	85,838	253,080	2.95	198	354
Total	2,117,358	7,987	108,762	2,234,107	3,923,701	1.76	174	4,652

[a] Pope and Washington.
[b] Logan, Pope, and Washington.

A statement of the production of coal in Arkansas, by counties, for the last five years, with increase and decrease in 1913 as compared with 1912, is shown in the following table:

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Coal production of Arkansas, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Franklin	281,399	296,725	421,591	373,314	346,682	− 26,632
Johnson	171,102	133,365	137,081	192,326	166,208	− 26,118
Logan	25,169	15,492	11,974	15,272	5,028	− 10,244
Pope	56,344	13,240	45,935	64,216	79,608	+ 15,392
Sebastian	1,818,781	1,425,347	1,484,532	1,454,128	1,635,379	+ 181,251
Other counties and small mines	24,362	21,789	5,676	1,563	1,202	− 361
Total	2,377,157	1,905,958	2,106,789	2,100,819	2,234,107	+ 133,288
Total value	$3,523,139	$2,979,213	$3,396,849	$3,582,789	$3,923,701	+$340,912

Arkansas contains two coal fields—one of high-grade fuel, in the western part of the State, and the other of lignite, in the lowlands southeast of Hot Springs and Little Rock. The latter has never been adequately developed, because lignite has had little or no commercial value, and it is probable that this field will not be an important factor in the fuel production of the State for some time to come.

The field of high-grade fuel lies along Arkansas River, extending from the Oklahoma State line on the west to Russellville on the east, a distance of about 75 miles. In the north-south direction its width, though differing much in different localities, probably averages about 20 miles. It includes in whole or in part the counties of Sebastian, Franklin, Johnson, Pope, Logan, Scott, and Crawford, but nearly all of the coal at present mined comes from the four counties standing at the head of the list.

Only a few coal beds occur in this field. The most important, from which probably 99 per cent of the coal mined in the State is derived, corresponds with the Hartshorne coal of Oklahoma, and, in fact, is the direct eastward extension of that bed. This coal is mined extensively at Huntington, Hartford, Midland, Bonanza, Jenny Lind, Greenwood, and other places in Sebastian County; at Denning and Altus, in Franklin County; at Clarksville, in Johnson County; and in the vicinity of Russellville, in Pope County.

The Charleston coal bed, about 700 feet higher than the Hartshorne bed, is mined in a small way about Charleston, Franklin County, and the Paris bed, about 300 feet higher than the Charleston, is mined locally in the vicinity of Paris, Logan County. Another small coal bed lies about 500 feet below the Hartshorne, but it is irregular and of little value, and at the present time is not mined on a commercial scale at any place in the State.

In quality the coal increases from west to east. The fuel ratio (fixed carbon divided by volatile matter) ranges from about 3.5 in the vicinity of the State line on the west to 5 at Denning and Coal Hill, 6.5 at Spadra, and about 8 at Russellville. In other words, the coal in the western part of the field belongs to the class called semibituminous, and that of the east to the class called semianthracite. The semibituminous coal of the western half of the field is exceedingly tender and friable and, as delivered at the mine mouth, consists of from 30 to 40 per cent fine coal. This fine coal is of excellent quality, but does not find a ready market, and frequently

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can not be disposed of at any price. This condition makes mining expensive and unsatisfactory.

According to the United States census for 1840 a small quantity of coal (220 short tons) was mined in Arkansas during that year. With the exception of 9,972 short tons mined in Missouri and 400 tons from Iowa mines, this was the only coal produced west of Mississippi River in that year, and for the next 20 years they were the only States west of the Mississippi from which any coal production was reported. The industry in Arkansas did not develop rapidly during the earlier years, as the census of 1860 shows a production of only 200 tons and that of 1880 a total of 14,778 tons. From 1881 to 1902 production increased quite regularly, but for the last 12 years has remained practically stationary. The production of 2,234,107 tons in 1913 was only 112,847 tons more than the average annual production from 1902 to 1913, inclusive. The maximum of 2,670,438 short tons was attained in 1907.

The annual production of coal in Arkansas from 1840 to the close of 1913 will be found in the following table:

Production of coal in Arkansas from 1840 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	220	1888	276,871	1898	1,205,479	1908	2,078,357
1860	200	1889	279,584	1899	843,554	1909	2,377,157
1880	14,778	1890	399,888	1900	1,447,945	1910	1,905,958
1881	20,000	1891	542,379	1901	1,816,136	1911	2,106,789
1882	25,000	1892	535,558	1902	1,943,932	1912	2,100,819
1883	50,000	1893	574,763	1903	2,229,172	1913	2,234,107
1884	75,000	1894	512,626	1904	2,009,451		
1885	100,000	1895	598,322	1905	1,934,673	Total	36,559,588
1886	125,000	1896	675,374	1906	1,864,268		
1887	129,600	1897	856,190	1907	2,670,438		

CALIFORNIA.

Total production in 1913, 24,839 short tons; spot value, $84,073.

Coal mining and the coal trade generally in California lay little claim to importance among the industries of the State, particularly since the beginning of the present century, when the production of petroleum began to exert such a powerful influence on the fuel consumption of the Pacific coast. From 1910 to 1912, inclusive, the coal production of California was only a little more than 10,000 tons in each year, but in 1913 work was resumed on the Stone Canyon properties in Monterey County, and the production increased to 24,839 short tons, valued at $84,073, from 10,978 tons, valued at $23,601, in 1912. The only other production in 1913 was from the Ione mines in Amador County, whose output was slightly less than in 1912.

The production of petroleum in California in 1913 amounted to 97,788,525 barrels, and it is estimated by David T. Day,[1] of the United States Geological Survey, that 63,000,000 barrels were used directly for fuel. It is also estimated that 3½ barrels of petroleum are equivalent to 1 short ton of ordinary bituminous coal, from which it appears that about 18,000,000 tons of coal would be required to

[1] See current report on production of petroleum: U. S. Geol. Survey Mineral Resources, 1913, 1914.

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perform the service rendered by California petroleum in the production of heat and power and in the manufacture of gas. California oil is the principal fuel for locomotives as far north as Washington and across the Sierras and the Cascades, its freedom from sparks serving as a great protection against forest fires as compared with coal or wood fuel. It is used almost exclusively on inland and coastwise steamers and, to an increasing extent, by the trans-Pacific steamers. It has even displaced coal on Puget Sound, many of the steamers of the Canadian Pacific fleet plying between Vancouver, Victoria, and other points having been equipped for burning oil. There is still, however, some demand for coal in California, particularly for domestic use and for bunker trade at San Francisco; but it is almost exclusively supplied by coals from other States—Washington, Utah, Wyoming, and New Mexico—and from foreign countries, chiefly British Columbia, with small quantities of anthracite and high-grade bituminous coals from the Eastern States. The railroads entering California brought from the Rocky Mountain States in 1913 a total of 363,123 short tons of coal; the receipts by water at San Francisco from Oregon, Washington, and Eastern States were 193,962 long tons, or 207,236 short tons; and the imports into San Francisco, Los Angeles, and San Diego reported by the Bureau of Foreign and Domestic Commerce of the Department of Commerce were 217,070 long tons (243,148 short tons)—a total of 813,507 short tons. The total consumption of coal in California, including that supplied to the bunker trade, which, with the United States naval vessels, probably takes the larger part of the coal received by water, was only 4.5 per cent of the quantity of coal displaced by the use of California petroleum.

The statistics of coal production in California during the last five years, with the distribution of the product for consumption, are shown in the following table:

Distribution of the coal product of California, 1909–1912, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1909	34,888	3,297	7,651	45,836	95,042	2.07	.....	14
1910	6,679	3,985	500	11,164	18,336	1.64	192	14
1911	4,981	5,266	500	10,747	16,097	1.50	254	45
1912	3,748	3,630	3,600	10,978	23,601	2.15	184	52
1913	14,864	1,808	8,167	24,839	84,073	3.38	332	35

There are in California a number of small, widely separated coal fields, chief among them the Mount Diablo field of Contra Costa County, the Corral Hollow field of Alameda County, a small area in Amador County, the Priest Valley and Trafton fields of San Benito County, and the Stone Canyon field of Monterey County. The first two, which are on the eastern border of San Francisco Bay, and consequently in the west-central part of the State, produce black lignite or subbituminous coal. The areas in Monterey County are more to the south and in or near a region which has been considerably dis-

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torted. The coals are of the same geologic age as those farther north, but they have been altered into true bituminous coals. The alteration in the San Benito County area has not progressed so far as in the case of the Monterey County coals, but they closely approach the bituminous grade. None of them possess coking qualities.

The records of the State Mining Bureau of California show a production of coal in that State as early as 1861. It was at that time one of the 16 coal-producing States and, relatively, of some importance as a coal producer. During the latter part of that decade and throughout the following decade the coal production of California exceeded 100,000 tons annually and reached a maximum of 236,950 tons in 1880. Since 1881 the production has been irregular, having been influenced chiefly, up to the beginning of the present century, by the imports of Australian and British Columbian coals, the receipts of Australian coals depending principally upon the wheat production and shipments from the Pacific coast. Since 1900, with the great increase in the production and use of petroleum which began in that year, coal production in California has fallen to an insignificant quantity.

The production of coal in California from 1861 to the close of 1913 is shown in the following table:

Production of coal in California from 1861 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1861	6,620	1875	166,638	1889	119,820	1903	104,673
1862	23,400	1876	128,049	1890	110,711	1904	78,888
1863	43,200	1877	107,789	1891	93,301	1905	77,050
1864	50,700	1878	134,237	1892	85,178	1906	25,290
1865	60,530	1879	147,879	1893	72,603	1907	13,950
1866	84,020	1880	236,950	1894	67,247	1908	18,755
1867	124,690	1881	140,000	1895	75,453	1909	45,836
1868	143,676	1882	112,592	1896	78,544	1910	11,164
1869	157,234	1883	76,162	1897	87,992	1911	10,747
1870	141,890	1884	77,485	1898	145,888	1912	10,978
1871	152,493	1885	71,615	1899	160,915	1913	24,839
1872	190,859	1886	100,000	1900	171,708		
1873	186,611	1887	50,000	1901	151,079	Total	5,153,264
1874	215,352	1888	95,000	1902	84,984		

COLORADO.

Total production in 1913, 9,232,510 short tons; spot value, $14,035,090.

Compared with 1912, when the production of coal in Colorado amounted to 10,977,824 short tons valued at $16,345,336, the returns for 1913 show a decrease of 1,745,314 tons, or 15.9 per cent, in quantity and of $2,310,246, or 14.13 per cent, in value. The smaller production in 1913 was due entirely to the inauguration of a strike, called on September 16 and put into effect a week later, which reduced the output in the southern part of the State for the rest of the year to about 40 per cent of the normal. The production in 1913 was the smallest since 1905. As has been the case in numerous other instances of labor disaffection, the trouble in Colorado arose from a demand for the recognition of the union and eventuated in a contest which for bitterness, violence, and bloodshed has exceeded any similar conflict in recent history, necessitating first the State militia, and finally the

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presence of Federal troops to restore and maintain order. At the time of writing this report (June, 1914), a condition of warfare still exists, although mining has been resumed with nearly a full complement of men under the protection of the Federal authorities. Few of the mines were rendered entirely idle at any time during the strike, and although 7,324 men (more than 60 per cent of the average number employed during the year) were idle for an average of 75 days each, the average number of days the mines worked was 229, or 2 days more than in 1912, when a production of practically 11,000,000 tons was mined without a single instance of strike or suspension being reported. The total time lost was equal to 20 per cent of the time made, from which it appears that except for the strike the production for the year would have amounted to about 11,500,000 tons, or within half a million tons of the maximum record of 1910. It is doubtful, however, if with no interruption by strikes, the output would have reached the possible tonnage, or even the record of 1912, for owing to crop shortage in adjoining States, there was a reduced demand for coal for both railroad and commercial purposes. Up to the time the strike was inaugurated the production was about 100,000 tons less than for the corresponding period in 1912. There was no complaint of car shortage or other inadequate transportation facilities in 1913.

The average number of men employed in the coal mines of Colorado in 1913 was 11,990, working an average of 229 days, against 13,000 men for 227 days in 1912. The miners of Colorado have a good record for efficiency. In 1912 the average production by each man employed was 844 tons, and in 1913 it was 770 tons; the average daily production per man was 3.7 tons in 1912 and 3.36 tons in 1913. Of the total output of 9,232,510 short tons in 1913, 5,592,638 tons, or 60.6 per cent, were mined by hand; 2,311,493 tons, or 25 per cent, by machines; and 1,286,293 tons, or 13.9 per cent, were shot off the solid. The last method shows a decrease in quantity but an increase in percentage as compared with 1912, when 1,309,544 tons, or 11.9 per cent, were "powder-mined." There was a decrease in the number of machines in use, from 304 in 1912 to 300 in 1913. More than half of the machines in use are of the pick or puncher type, 168 in 1913 being of that type. Of the remainder, 35 were chain breast, 12 were long wall, 80 were short wall, or continuous cutters, and 5 were radial-ax or post punchers. The quantity of coal washed, most of which is slack used for coke-making, was 328,016 tons, the cleaned coal amounting to 266,281 tons and the refuse to 61,735 tons.

Reports to the Bureau of Mines show that there were 108 fatal accidents in the coal mines of Colorado in 1913, an increase of 13 over 1912. Of the total deaths 47 were due to falls of roof and coal, 37 to gas and dust explosions, 7 to mine cars and locomotives, and 17 (3 of which were on the surface), were due to other causes.

The statistics of production in Colorado in 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

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Coal production of Colorado in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Boulder	981,784	18,618	54,523	.....	1,054,925	$1,707,385	$1.62	190	1,316
Delta	57,329	16,030	1,684	.....	75,043	138,784	1.85	163	83
El Paso	206,341	118,873	9,690	.....	334,904	479,053	1.43	262	412
Fremont	689,860	23,918	25,055	.....	738,833	1,603,259	2.17	198	1,340
Garfield	175,619	2,520	7,313	.....	185,452	254,687	1.37	250	178
Gunnison	501,147	2,080	20,594	33,864	557,685	831,733	1.49	201	661
Huerfano	1,804,837	13,102	81,599	.....	1,899,538	3,226,064	1.70	213	2,443
La Plata	108,612	15,442	912	7,521	132,487	231,631	1.75	217	164
Las Animas	3,844,200	41,687	97,642	725,169	4,708,698	5,864,060	1.25	262	4,895
Mesa	80,826	30,167	3,500	.....	114,493	159,544	1.39	196	135
Routt	429,359	3,675	15,227	.....	448,261	783,499	1.75	200	480
Weld	445,479	26,491	19,067	.....	491,037	726,002	1.48	206	536
Other counties [a]	201,756	4,785	15,745	.....	222,286	313,325	1.41	169	357
Small mines	.....	14,182	.....	.....	14,182	26,310	1.86	.....	.....
Total	9,527,149	331,570	352,551	766,554	10,977,824	16,345,336	1.49	227	13,000

1913.

Boulder	846,402	12,778	43,738	.....	902,918	$1,539,062	$1.70	242	1,178
Delta	71,235	14,019	1,210	.....	86,464	130,631	1.51	176	102
El Paso	169,660	141,128	16,111	.....	326,899	487,419	1.49	240	415
Fremont	487,617	28,161	20,000	.....	535,778	1,097,320	2.05	170	1,291
Garfield	148,545	2,523	7,594	.....	158,662	211,664	1.33	220	179
Gunnison	412,263	2,380	22,730	35,380	472,753	726,846	1.54	195	622
Huerfano	1,626,739	10,599	67,902	.....	1,705,240	2,822,242	1.66	208	2,351
La Plata	102,580	23,651	1,121	12,703	140,055	238,354	1.70	241	187
Las Animas	2,236,957	57,028	91,253	1,354,119	3,739,357	4,915,606	1.31	269	4,293
Mesa	101,527	28,346	4,565	.....	134,438	197,182	1.47	232	127
Routt	315,325	5,183	14,453	.....	334,961	578,195	1.73	160	431
Weld	363,392	26,667	19,072	.....	409,131	667,622	1.63	224	468
Other counties [b]	254,391	4,404	18,500	210	277,505	406,716	1.47	218	346
Small mines	.....	8,349	.....	.....	8,349	16,231	1.94	.....	.....
Total	7,136,633	365,216	328,249	1,402,412	9,232,510	14,035,090	1.52	229	11,990

[a] Archuleta, Jackson, Jefferson, Montezuma, and Pitkin.
[b] Archuleta, Jackson, Jefferson, Pitkin, and Rio Blanco.

As the scene of the greater part of the labor struggle in 1913 was in Las Animas County, that county sustained the heaviest loss in tonnage, as compared with 1912. The decrease in Las Animas County was 969,341 tons, or more than 20 per cent, and was more than half the total decrease in the State. Fremont County's production decreased 203,055 tons; Huerfano's, 194,298 tons; Boulder's, 152,007 tons; and Routt's, 113,300 tons. Only 3 of the 14 counties included in the following table showed increased production in 1913, and they were relatively small producers.

The statistics of production, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912, are given in the following table:

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Coal production in Colorado, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Boulder	1,332,322	802,769	954,752	1,054,925	902,918	− 152,007
Delta	55,031	63,590	71,399	75,043	86,464	+ 11,421
El Paso	312,233	336,780	332,155	334,904	326,899	− 8,005
Fremont	611,980	722,142	661,240	738,833	535,778	− 203,055
Garfield	257,796	189,755	165,908	185,452	158,662	− 26,790
Gunnison	598,463	640,982	575,648	557,685	472,753	− 84,932
Huerfano	1,915,910	2,387,090	1,786,654	1,899,538	1,705,240	− 194,298
Jefferson	195,809	227,744	1,187	94,534	155,928	+ 61,394
La Plata	139,858	147,755	96,749	132,487	140,055	+ 7,568
Las Animas	4,592,964	5,548,085	4,458,753	4,708,698	3,739,357	− 969,341
Mesa	98,241	129,530	92,881	114,493	134,438	+ 19,945
Pitkin	159,753	183,068	101,773	74,683	53,317	− 21,366
Routt	92,439	258,452	317,791	448,261	334,961	− 113,300
Weld	327,545	322,896	520,396	491,037	409,131	− 81,906
Other counties [a]	26,592	13,098	20,097	67,251	76,609	+ 9,358
Total	10,716,936	11,973,736	10,157,383	10,977,824	9,232,510	− 1,745,314
Total value	$14,296,012	$17,026,934	$14,747,764	$16,345,336	$14,035,090	−$2,310,246

[a] Includes small mines.

The coal fields of Colorado are divided by the major ranges of the Rocky Mountains into three general groups designated as the eastern, the park, and the western. The eastern group, the most highly developed of the three, comprises the Denver region and the Canon City and Trinidad fields. The park group includes the little known and almost undeveloped fields of the South, Middle, and North parks. The western group, the largest in area, which contains the greatest amount of coal, includes the Yampa field on the north, the Danforth Hills, White River, and Grand Hogback fields north of Grand River, the Glenwood Springs, Crested Butte, and Grand Mesa fields south of Grand River, the Book Cliffs field west of Grand Junction, and the Durango field in the southwestern part of the State. All of these fields of the western group, with the exception of the Yampa field, in the extreme north, and the Durango field, in the south, belong to the great Uinta region, or basin, which extends from Gunnison County, Colo., on the east, to Carbon and Emery counties, in the central part of Utah, on the west.

In quality the coals of Colorado range from subbituminous ("black lignite"), in the Denver region, through various grades of bituminous, including the high-grade coking coal of the Trinidad and Glenwood Springs fields, to true anthracite, in the Crested Butte and Yampa fields. Some of the coal beds of Colorado attain enormous thickness. This is especially true in the Glenwood Springs field, and some of the beds in the North Park field are also said to be of great thickness. The total area underlain by coal in Colorado is estimated at 17,130 square miles, and about 60 per cent of that entire area is believed to contain coal workable under present conditions. There is an extent of territory embracing over 4,000 square miles about which little is known, but which may contain workable coal, and nearly 3,000 square miles of territory in which the coal lies under heavy cover and is not workable on that account at the present time.

Coal mining as an industry in Colorado began in 1864, a production of 500 short tons being recorded in that year. In 1876 the production reached for the first time a total exceeding 100,000 tons, and six

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years later, in 1882, it had reached the million-ton mark. Since that date the increase has been almost uninterrupted, there being only five times prior to 1911 (in 1884, 1892, 1894, 1904, and 1908) when the production showed a decrease of any importance, and only six times altogether in 38 years. The largest decrease was in the "hard-times" year, 1894. The coal production of the State exceeded 3,000,000 tons in 1890; 10 years later it had grown to over 5,000,000 tons; in 1910 it exceeded 11,000,000 tons; but in 1911, 1912, and 1913 it fell below the 11,000,000-ton mark.

The record, by years, since 1864 is shown in the following table:

Production of coal in Colorado from 1864 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1864	500	1877	160,000	1890	3,077,003	1903	7,423,602
1865	1,200	1878	200,630	1891	3,512,632	1904	6,658,355
1866	6,400	1879	322,732	1892	3,510,330	1905	8,826,429
1867	17,000	1880	462,747	1893	4,102,389	1906	10,111,218
1868	10,500	1881	706,744	1894	2,831,409	1907	10,790,236
1869	8,000	1882	1,061,479	1895	3,082,982	1908	9,634,973
1870	4,500	1883	1,229,593	1896	3,112,402	1909	10,716,936
1871	15,600	1884	1,130,024	1897	3,361,703	1910	11,973,736
1872	68,540	1885	1,356,062	1898	4,076,347	1911	10,157,383
1873	69,997	1886	1,368,338	1899	4,776,224	1912	10,977,824
1874	77,372	1887	1,791,735	1900	5,244,364	1913	9,232,510
1875	98,838	1888	2,185,477	1901	5,700,015		
1876	117,666	1889	2,597,181	1902	7,401,343	Total	175,361,698

GEORGIA.

Total production in 1913, 255,626 short tons; spot value, $361,319.

The coal production of Georgia in 1913 was the largest in five years, or since 1908. Compared with 1912, when the output amounted to 227,503 short tons, valued at $338,426, the production in 1913 shows an increase of 28,123 short tons, or 12.36 per cent, in quantity and of $22,893, or 6.76 per cent, in value. The average price per ton declined from $1.49 to $1.41. The maximum production of coal in Georgia was 416,951 short tons, obtained in 1903, just 10 years before the year under review. For the next eight years, with the exception of 1907, the output steadily declined until a minimum of 165,210 tons was reached in 1911. A revival of activity is indicated in the returns for 1912 and 1913. The decrease in production from 1903 to 1911 and the increased output in the last two years were due entirely to peculiar labor conditions and not to the state of the trade and market requirements. Prior to 1904 the principal labor employed in the coal mines of Georgia consisted of convicts leased from the State government. An act of legislature prohibiting further leasing of convicts to industrial enterprises caused the gradual withdrawal from the coal mines of this labor as contracts expired, and operators in the somewhat isolated region where the mines are located were unable to supply the deficiency by free labor.

The influence of free labor on the efficiency record is shown by the fact that in 1907, when the principal labor was performed by convicts, it required 808 men, working an average of 262 days, to produce 362,401 tons, an average of 449 tons per man for the year and of 1.71 tons for each working day. In 1908 under similar conditions, 670 men, working 261 days, produced 264,822 tons, the corresponding

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averages being, respectively, 395 tons and 1.51 tons. In 1912, 450 men, working 254 days, produced 227,503 tons, and in 1913, 500 men, working 261 days, produced 255,626 tons, the averages per man being 506 tons for the year and 2 tons a day in 1912, and 511 tons for the year and 1.96 tons a day in 1913.

No mining machines are used in the coal mines of Georgia. The reports to the Survey show that all of the output in 1913 was shot off the solid. About one-third the entire production (82,943 tons in 1913) was washed coal. The total quantity of coal sent to the washeries in 1913 was 124,306 tons, of which 41,363 tons was discarded as refuse. Georgia "washed nut" has a high reputation as a steam and domestic fuel. All of the coal reported as washed in 1913 was slack used in the manufacture of coke.

The Bureau of Mines reports that 3 men were killed in the coal mines of Georgia in 1913, all of them by falls of roof. The death rate per thousand was 6 and the production for each life lost was 42,604 short tons.

The statistics of production during the last five years, with the distribution of the product for consumption, are shown in the following table:

Coal production of Georgia, 1909–1913, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1909	119,806	1,000	4,100	86,290	211,196	$298,792	$1.41	.....	460
1910	94,330	776	2,760	79,379	177,245	259,122	1.46	265	386
1911	86,141	957	5,435	72,677	165,210	246,208	1.49	278	510
1912	108,135	1,304	6,141	111,923	227,503	338,426	1.49	254	450
1913	122,499	1,303	7,518	124,306	255,626	361,319	1.41	261	500

The coal-productive area of Georgia underlies portions of two counties in the extreme northwestern corner of the State. The Walden Basin of Tennessee crosses Dade County in Georgia, and extending southwesterly becomes the Blount Mountain and Warrior basins in Alabama. The Lookout Basin, a narrow outlying area, extends from Etowah County, in Alabama, in a northeasterly direction into Walker County, Ga. The total area of the coal fields in Georgia is estimated at 167 square miles, the smallest coal area of any Appalachian State. Not all of the field is workable. Extensive operations have been carried on in both counties, however, but all of the production in 1913 was by two companies operating in Walker County. On account of its high percentage (80 per cent) of fixed carbon and its low sulphur content, the Lookout Mountain coal (Walker County) gives a large product of excellent coke which is sold to the furnaces of Chattanooga and of other points in Tennessee and in Georgia.

The Eighth United States Census contains the first authentic statement of the production of coal in Georgia. This report, which is for 1860, gives the production in that year as 1,900 short tons. The census for 1870 does not mention any production in Georgia for that year. The Tenth Census (1880) reports an output of coal for the State of

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154,644 short tons, since which time the production has been reported in Mineral Resources of the United States.

The annual production since 1860 is shown in the following table:

Annual production of coal in Georgia, 1860–1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1860	1,900	1874	60,000	1888	180,000	1902	414,083
1861	2,500	1875	80,000	1889	225,934	1903	416,951
1862	3,500	1876	110,000	1890	228,337	1904	383,191
1863	6,000	1877	120,000	1891	171,000	1905	351,991
1864	10,000	1878	128,000	1892	215,498	1906	332,107
1865	10,000	1879	140,000	1893	372,740	1907	362,401
1866	8,000	1880	154,644	1894	354,111	1908	264,822
1867	8,000	1881	168,000	1895	260,998	1909	211,196
1868	10,000	1882	160,000	1896	238,546	1910	177,245
1869	12,000	1883	155,000	1897	195,869	1911	165,210
1870	15,000	1884	150,000	1898	244,187	1912	227,503
1871	20,000	1885	150,000	1899	233,111	1913	255,626
1872	25,000	1886	223,000	1900	315,557		
1873	40,000	1887	313,715	1901	342,825	Total	9,425,298

IDAHO.

Total production in 1913, 2,143 short tons; spot value, $5,149.

The small output of coal in Idaho is from a few scattered lignite beds and is used locally.

The production in Idaho during the last six years has been as follows:

Coal production in Idaho, 1908–1913, in short tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1908	5,429	$21,832	1911	1,805	$4,808
1909	4,553	19,459	1912	2,319	6,603
1910	4,448	17,426	1913	2,143	5,149

ILLINOIS.

Total production in 1913, 61,618,744 short tons; spot value, $70,313,605.

The coal-mining industry of Illinois in 1913 presented some interesting and contradictory features. In the first place, the diminished supply of natural gas in Kansas caused an increased demand for Illinois coal in the territory naturally tributary to the Illinois coal fields but which for a few years had been supplied by gas, and during the last three months of the year the strike in the coal fields of Colorado caused a movement of Illinois coal to more western markets in order to supply the deficiency created by the strike. On the other hand, exceptionally mild weather in the early winter had a depressing influence on the domestic trade, and the water power developed by the Keokuk dam seriously affected the demand for and prices of steam coal within a radius of 250 miles from the power plant. It is estimated that the power furnished by the dam displaces about 3,000 tons of coal a day. The effect of these influences is shown by an increase in the quantity of coal produced from 59,885,226 short tons in 1912 to 61,618,744 tons in 1913, a gain of 1,733,518 tons, whereas the value showed scarcely any increase at all ($19,267), from

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$70,294,338 to $70,313,605. The average value per ton declined from $1.17 in 1912 to $1.14 in 1913. The decline in value was distributed generally over the State, there being only a few counties where the average prices in 1913 were higher than in 1912. Labor conditions were more satisfactory in 1913 than in 1912; but that there was much to be desired in that respect is shown by the facts that 11,861 men were on strike during the year, that the average time lost by the men on strike was 55 days, and that the average time made by all the employees in 1913 was reduced by 5 days, as compared with 1912. Transportation facilities were generally adequate. As in other States in the Middle West, floods in March and April interrupted coal-mining operations in many parts of Illinois, and then the drought, which began in June and lasted into October, increased mining expenses somewhat, as it necessitated hauling water for the power plants in order to keep the mines in operation.

There are more coal-producing counties in Illinois than in any other State in the Union, half of the 102 counties in the State being, or having been, producers. The two most important producing counties are in the southern part of the State, where the coal beds attain a greater thickness than in the northern districts. Williamson County in 1913 had an output of 7,644,397 tons, and Franklin County, 6,072,102 tons. Sangamon and Macoupin counties, which form the more important part of the Springfield-Belleville belt, are third and fourth, respectively, in producing importance, Sangamon contributing 5,875,853 tons and Macoupin 5,097,619 tons in 1913. St. Clair County, which forms the southwestern extremity of the Springfield-Belleville belt, is fifth in importance, with a production of 4,383,459 tons, and Saline County, on the southern border of the Illinois field, produced 4,189,003 tons in 1913. Two other counties, Madison and Vermilion, exceeded 3,500,000 tons in production, and three, Fulton, Montgomery, and Perry, produced over 2,000,000 tons. Five other counties had outputs exceeding 1,000,000 tons. The principal increase in the coal production of Illinois in 1913 was in Franklin County, where a large amount of development has taken place during the last three years, advancing the county from eighth place in 1910 to second in importance in 1913. Franklin County's increase in 1913 over 1912 was 1,629,818 short tons, or 37 per cent. No other county showed a gain of as much as 600,000 tons. Perry County, whose output showed the second largest increase, gained 569,014 tons, and Montgomery County's output increased 506,879 tons. The principal decreases in production were in St. Clair (351,381 tons), Marion (322,060 tons), Madison (293,725 tons), and Saline counties (228,871 tons). Coal mining on a commercial scale was carried on in 48 counties in Illinois during 1913, the production showing an increase in 21 counties and a decrease in 28. No production was reported in 1913 from Calhoun County, in which a small output was made in 1912.

Until 1909 Illinois ranked second in importance among the coal-producing States, although in one previous year, 1906, West Virginia temporarily displaced Illinois. In 1909 Illinois again dropped behind West Virginia, and has remained and will probably continue to remain indefinitely the third State in coal-producing importance. In 1913 West Virginia exceeded Illinois by approximately 10,000,000 tons.

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The increased efficiency in the labor employed in the coal mines of Illinois, as noted in the report of this series for 1912, continued in 1913, and was due chiefly to the larger production obtained through the use of mining machines. In 1913 the average production per man in the coal mines of Illinois was 775 tons for the year and 4.1 tons for each working day, against 767 tons for the year and 3.95 tons per day in 1912 and 701 tons for the year and 3.7 tons for each day in 1911. The quantity of coal mined by machines increased from 26,878,049 tons, or 44.9 per cent of the total, in 1912 to 32,630,555 tons, or 53 per cent in 1913. The increase in the quantity of machine-mined coal was 5,752,506 tons, or about 3⅓ times the total increase in the production of coal in the State. It is gratifying to note a corresponding decrease in the quantity of coal shot off the solid. In 1912 the quantity of coal mined by powder in the mines of Illinois was 24,136,940 tons, or 40 per cent of the total, and in 1913 that item amounted to 20,469,139 tons, or 33 per cent of the total. The quantity of coal mined by hand increased from 7,675,805 tons in 1912 to 8,069,361 tons in 1913, the percentages to the total being about the same in both years. The prevalence of solid shooting in the coal mines of Illinois has been little short of criminal, for it adds materially to the hazardous character of the miner's occupation and seriously impairs the quality of the product. The trade on which the mines of Illinois depend demands principally screened coal, with little sale for the slack or screenings except at greatly reduced price. Shooting off the solid adds largely to the percentage of the slack coal and increases the friability of the product which comes from the mines in lumps but breaks down rapidly in handling. With the increased use of coal-cutting machinery it is believed that within a few years little coal will be mined in Illinois without having been previously undercut or sheared. The flat-lying character of the Illinois coal beds is favorable to machine mining, and there appears to be no good reason for permitting solid shooting to continue. The number of machines in use increased from 1,654 in 1912 to 1,845 in 1913. The increase was entirely in the installation of chain-breast and long-wall machines. There were fewer punchers in use in 1913 than in 1912, the number of that type of machine having decreased from 847 in 1912 to 802 in 1913. The nunber of chain-breast machines, on the other hand, increased from 701 to 906. The number of long-wall machines increased from 22 to 55 and of short-wall machines from 81 to 82. Considerable quantities of Illinois coal are washed in preparation for the domestic trade, and washed Illinois egg and nut coals have a distinctive place in the markets. Many of the operators who cater to the domestic trade in Illinois coal carefully size their product by screens, sometimes as many as a half dozen sizes being prepared. Certain types of washers are much more effective when the coal has been screened before washing, and as a usual thing the washed coal has also been sized. In 1913 the quantity of Illinois coal washed was 4,190,960 tons, which yielded 3,664,928 tons of cleaned coal and 526,032 tons of refuse. The quantity of washed coal sold in Illinois in 1913 was nearly 600,000 tons greater than in 1912.

The casualty record of the coal mines of Illinois maintained by the Bureau of Mines shows that there were 164 fatal accidents in 1913, as compared with 159 in 1912 and 172 in 1911. All but 11 of the

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fatalities occurred under ground, and 80 of them (nearly 50 per cent) were due to falls of roof and coal. Haulage-way accidents were responsible for 38 deaths; explosions of gas killed 8; premature blasts and other accidents from explosives killed 11; and electric shocks and burns killed 8. Four men were killed in shafts and 7 on the surface. The death rate per thousand was 2.06 in 1913 against 2.04 in 1912 and 2.25 in 1911. The quantity of coal mined for each life lost was 375,724 short tons, against 376,637 in 1912 and 312,088 in 1911.

The statistics of production, by counties, in 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

Coal production of Illinois in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bureau	1,560,490	48,706	68,121	1,677,317	$2,736,737	$1.63	224	3,808
Christian	1,250,722	152,163	64,961	1,467,846	1,687,823	1.15	167	2,075
Clinton	978,791	12,947	48,741	1,040,479	1,073,188	1.03	171	1,336
Franklin	4,282,721	39,878	119,685	4,442,284	5,389,076	1.21	204	4,499
Fulton	2,337,698	54,323	61,403	2,453,424	3,193,202	1.30	201	3,578
Gallatin	48,977	14,399	868	64,244	72,295	1.13	147	164
Grundy	480,549	30,690	29,548	540,787	963,365	1.78	162	1,595
Henry	17,000	39,863	1,750	58,613	104,602	1.78	174	126
Jackson	629,550	29,806	48,834	703,190	968,303	1.38	160	1,068
Knox	----------	21,417	876	22,293	39,765	1.78	163	60
La Salle	1,156,290	307,696	73,605	1,537,591	2,706,718	1.76	224	3,275
Livingston	24,918	39,219	1,637	65,774	130,847	1.99	216	127
Logan	392,374	56,638	17,516	466,528	574,713	1.23	186	678
McDonough	3,178	10,954	314	14,446	31,820	2.20	178	48
Macon	148,443	136,047	7,100	291,590	413,179	1.42	163	581
Macoupin	4,791,107	80,155	115,312	4,986,574	4,894,191	.98	206	5,061
Madison	3,804,878	124,515	96,485	4,025,878	4,386,020	1.09	184	4,466
Marion	1,221,716	48,313	40,995	1,311,024	1,406,346	1.07	224	1,401
Marshall	361,335	66,443	21,882	449,660	812,020	1.81	240	1,065
Menard	116,431	53,797	7,350	177,578	240,850	1.36	169	335
Mercer	364,886	15,635	12,497	393,018	594,171	1.51	209	479
Montgomery	2,092,984	43,122	46,717	2,182,823	2,348,084	1.08	192	2,665
Peoria	1,097,830	101,958	25,786	1,225,574	1,580,021	1.29	213	1,721
Perry	1,361,180	31,128	51,806	1,444,114	1,518,746	1.05	146	1,968
Randolph	752,609	30,924	14,630	798,163	814,022	1.02	138	1,116
Rock Island	15,456	47,477	3,884	66,817	107,377	1.61	180	122
St. Clair	4,437,137	182,573	115,130	4,734,840	4,656,454	.98	162	5,799
Saline	4,293,035	34,699	89,540	4,417,874	4,924,339	1.11	204	5,204
Sangamon	5,260,048	298,353	156,341	5,714,742	6,335,965	1.11	178	7,030
Shelby	153,045	24,210	8,246	185,501	252,965	1.36	142	339
Stark	10,881	21,845	1,450	34,176	57,128	1.67	188	43
Tazewell	192,423	71,224	7,674	271,321	348,063	1.28	225	376
Vermilion	3,179,572	201,243	54,108	3,434,923	3,940,780	1.15	234	4,149
Will	111,833	14,063	4,910	130,806	242,905	1.86	201	408
Williamson	6,982,822	69,188	302,497	7,354,507	8,214,769	1.12	187	8,602
Other counties[a] and small mines	1,391,021	238,250	69,636	1,698,907	2,531,689	1.49	229	2,731
Total	55,304,530	2,793,861	1,786,835	59,885,226	70,294,338	1.17	194	78,098

[a] Bond, Calhoun, Edgar, Greene, Jefferson, McLean, Morgan, Moultrie, Putnam, Schuyler, Scott, Warren, Washington, White, and Woodford.

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Coal production of Illinois in 1912 and 1913, by counties, in short tons—Continued.

1913.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bureau	1,514,958	55,964	68,286	1,639,208	$2,614,561	$1.60	207	3,790
Christian	1,353,559	79,286	71,871	1,504,716	1,672,004	1.11	156	2,294
Clinton	1,001,903	11,601	36,071	1,049,575	1,021,262	.97	157	1,377
Franklin	5,872,038	42,254	157,810	6,072,102	7,007,904	1.15	220	5,662
Fulton	2,282,585	45,766	60,424	2,388,775	3,055,825	1.28	191	3,569
Gallatin	41,214	3,884	1,007	46,105	50,835	1.10	113	148
Grundy	361,221	23,598	16,708	401,527	663,649	1.65	153	1,148
Henry	320	41,388	1,675	43,383	79,015	1.82	180	113
Jackson	641,946	27,912	54,005	723,863	1,028,754	1.42	174	974
Knox	.....	17,672	608	18,280	34,318	1.88	189	51
La Salle	1,125,740	364,790	73,929	1,564,459	2,738,704	1.75	237	2,893
Livingston	1,524	61,154	1,199	63,877	104,901	1.64	248	100
Logan	268,696	55,273	27,697	351,666	435,250	1.24	193	597
McDonough	1,682	10,921	.....	12,603	27,656	2.19	161	35
Macoupin	4,908,004	71,020	118,595	5,097,619	5,057,710	.99	193	5,472
Madison	3,534,531	105,390	92,232	3,732,153	3,824,161	1.02	157	4,393
Marion	945,572	18,356	25,036	988,964	998,143	1.01	175	1,438
Marshall	340,639	62,174	23,677	426,490	776,171	1.82	217	1,078
Menard	77,673	35,577	6,924	120,174	151,633	1.26	148	281
Mercer	374,846	18,305	15,724	408,875	580,790	1.42	198	581
Montgomery	2,603,826	37,975	47,901	2,689,702	2,797,777	1.04	187	3,086
Peoria	1,048,737	91,910	22,426	1,163,073	1,432,687	1.23	206	1,519
Perry	1,918,763	30,146	64,219	2,013,128	2,055,441	1.02	190	2,267
Randolph	711,894	28,316	23,262	763,472	772,579	1.01	149	1,003
Rock Island	2,062	29,810	3,800	35,672	54,677	1.53	132	75
St. Clair	4,105,508	187,707	90,244	4,383,459	4,192,122	.96	175	4,785
Saline	4,065,766	33,728	89,509	4,189,003	4,739,217	1.13	200	4,911
Sangamon	5,457,986	255,273	162,594	5,875,853	6,277,960	1.07	164	7,775
Shelby	165,489	18,678	9,465	193,632	259,053	1.34	167	406
Stark	3,775	10,315	520	14,610	26,060	1.78	141	46
Tazewell	268,412	67,015	6,199	341,626	417,709	1.22	246	433
Vermilion	3,268,325	174,752	58,803	3,501,880	4,007,167	1.14	214	4,058
Wise	130,668	14,358	4,900	149,926	285,640	1.91	187	387
Williamson	7,379,489	67,203	197,705	7,644,397	8,263,104	1.08	180	9,472
Other counties and small mines [a]	1,549,728	369,486	85,683	2,004,897	2,809,166	1.40	214	3,312
Total	57,329,079	2,568,957	1,720,708	61,618,744	70,313,605	1.14	189	79,529

[a] Bond, Greene, Jefferson, McLean, Macon, Morgan, Moultrie, Putnam, Schuyler, Scott, Warren, Washington, White, and Woodford.

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In the following table are shown the statistics of production of coal in Illinois, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912:

Coal production of Illinois, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Bond	89,861	139,398	119,250	232,571	223,786	− 8,785
Bureau	1,612,452	973,346	1,628,688	1,677,317	1,639,208	− 38,109
Calhoun			1,400	1,156		− 1,156
Christian	1,395,158	1,223,295	1,222,259	1,467,846	1,504,716	+ 36,870
Clinton	970,709	950,243	921,225	1,040,479	1,049,575	+ 9,096
Franklin	2,316,509	1,778,768	3,555,586	4,442,284	6,072,102	+1,629,818
Fulton	2,388,617	1,721,527	2,133,029	2,453,424	2,388,775	− 64,649
Gallatin	64,713	70,091	63,008	64,244	46,105	− 18,139
Greene	7,318	9,082	6,207	7,841	5,009	− 2,832
Grundy	1,114,101	600,281	776,800	540,787	401,527	− 139,260
Hancock	1,085	640	230			
Henry	137,060	124,243	90,722	58,613	43,383	− 15,230
Jackson	652,280	584,240	687,753	703,190	723,863	+ 20,673
Jefferson	4,800	10,000	9,500	21,032	35,000	+ 13,968
Jersey	1,000					
Kankakee	25,000					
Knox	21,973	28,295	30,136	22,293	18,280	− 4,013
La Salle	1,686,391	1,178,885	1,610,470	1,537,591	1,564,459	+ 26,868
Livingston	246,031	162,898	89,423	65,774	63,877	− 1,897
Logan	395,888	409,244	334,860	466,528	351,666	− 114,862
McDonough	16,276	26,338	8,027	14,446	12,603	− 1,843
McLean	116,412	83,982	96,517	89,781	88,777	− 1,004
Macon	238,607	235,361	236,203	291,590	206,140	− 85,450
Macoupin	4,597,775	3,854,229	4,688,212	4,986,574	5,097,619	+ 111,045
Madison	3,373,798	4,102,773	3,152,705	4,025,878	3,732,153	− 293,725
Marion	1,171,950	812,873	1,224,326	1,311,024	988,964	− 322,060
Marshall	295,812	267,447	423,984	449,660	426,490	− 23,170
Menard	303,948	332,557	190,477	177,578	120,174	− 57,404
Mercer	369,762	229,024	297,552	393,018	408,875	+ 15,857
Montgomery	1,780,668	1,799,720	2,395,814	2,182,823	2,689,702	+ 506,879
Morgan	1,200	1,300	1,268	1,000	1,222	+ 222
Peoria	914,961	810,595	1,037,362	1,225,574	1,163,073	− 62,501
Perry	1,423,135	1,367,771	1,272,292	1,444,114	2,013,128	+ 569,014
Putnam	597,703	364,882	772,976	720,048	724,170	+ 4,122
Randolph	799,893	1,025,557	777,746	798,163	763,472	− 34,691
Rock Island	46,228	66,207	65,983	66,817	35,672	− 31,145
St. Clair	3,471,630	5,788,567	3,931,479	4,734,840	4,383,459	− 351,381
Saline	3,283,939	2,459,650	3,820,410	4,417,874	4,189,003	− 228,871
Sangamon	5,616,357	4,449,634	5,137,835	5,714,742	5,875,853	+ 161,111
Schuyler	4,573	2,427	6,138	4,573	1,855	− 2,718
Scott	2,056	2,400	464	460	600	+ 140
Shelby	124,087	135,672	81,615	185,501	193,632	+ 8,131
Stark	23,159	32,582	37,293	34,176	14,610	− 19,566
Tazewell	208,049	155,659	220,783	271,321	341,626	+ 70,305
Vermilion	1,919,955	2,515,250	3,385,200	3,434,923	3,501,880	+ 66,957
Warren	12,304	10,275	9,044	5,021	3,383	− 1,638
Washington	31,322	22,500	25,000	244,879	319,370	+ 74,491
White	22,133	23,722	35,681	27,052	22,304	− 4,748
Will	162,307	124,652	178,397	130,806	149,926	+ 19,120
Williamson	6,537,654	4,620,372	6,614,029	7,354,507	7,644,397	+ 289,890
Woodford	194,410	125,823	164,001	185,499	a302,184	+ 116,685
Small mines	111,981	85,909	109,759	157,994	71,097	− 86,897
Total	50,904,990	45,900,246	53,679,118	59,885,226	61,618,744	+1,733,518
Total value	$53,522,014	$52,405,897	$59,519,478	$70,294,338	$70,313,605	+ $19,267

a Includes production of Moultrie County.

There are 102 counties in Illinois, and coal has been mined in 51 of them. The coal formations underlie a number of other counties, the total productive territory occupying nearly three-fourths of the entire State. The total coal area is estimated at 35,600 square miles, the largest area in any State east of Mississippi River and exceeded only by those of Montana and North Dakota. The coal fields comprise the western part of a broad and relatively flat basin whose east-

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ern border is in the western part of Indiana and whose southern extremity extends under Ohio River into Kentucky. The principal developments are in the northern, western, and southern borders from Grundy, La Salle, and Bureau counties on the north, to Williamson, and Saline counties on the south, with a somewhat isolated district in Vermilion County at the northeast. These developments are divided more into districts or regions from a commercial standpoint than into distinct fields determined by geologic conditions, though of course the accessibility of the beds at relatively shallow depths, or the thickness and quality of the coal, has influenced their exploitation. Among the principal mining districts are the Mazon Creek region of Grundy and Livingston counties; the Streator-Spring Valley district of Bureau and La Salle counties; the Peoria district; the Springfield-Belleville belt, including Sangamon, Christian, Macoupin, Montgomery, Madison, and St. Clair counties; the Southwestern district, including Washington, Perry, Franklin, Jackson, and Williamson counties; the Harrisburg district of Saline County; and the Danville district in Vermilion County. Of these districts, the Springfield-Belleville belt is the most important, contributing nearly 40 per cent of the State's total output of coal.

The coal production of Illinois is from six different beds, Nos. 1, 2, 3, 5, 6, and 7, but in some cases doubt exists as to the exact correlation of the beds, Nos. 6 and 7 being especially confused locally. It has been demonstrated that what is generally designated as No. 7, in southeastern Illinois, is identical with No. 6 in the southwestern part of the State. Bed No. 6 is by far the most important one in the State. It averages 6 feet in thickness over a wide extent of territory, and is mined at depths varying from 50 to 800 feet. Nearly 60 per cent of the total output of the State is from this bed, and if to the coal reported as from No. 6 is added that reported as from No. 7 (which ought to be No. 6) the percentage from this bed would probably exceed 60. The mines operated on No. 6 coal, about 275 in number, average over 100,000 tons each in production.

Bed No. 5, which is the one chiefly worked in the Danville district, and in the north-central and southeastern parts of the State, is second in importance and produces something over 25 per cent of the total, and bed No. 2, or "Big Muddy," produces a little over 10 per cent.

The first mention of coal in the territory which afterward became the United States is contained in the Journal of Father Louis Hennepin,[1] published in 1698. This journal contains a map on which is marked "cole mine" on the banks of Illinois River near the site of the present city of Ottawa, Hennepin having passed through this region 30 years before, in 1668. After the discovery of coal in Illinois, however, nearly a century and a half elapsed before mining began. The Journal of the Franklin Institute for 1836 states that the first actual mining operations conducted by white men were at the Mount Carbon mines, near Brownsville, in Jackson County, on the banks of Big Muddy River, a short distance from its junction with the Mississippi. These mines were opened in 1810 and worked to a limited extent for many years.[2] Another region, said to have been

[1] Voyage de nouvelle découverte du très grand pays de l'Amérique. Amsterdam, 1698.
[2] Macfarlane, James, Coal regions of America, p. 421. New York, 1873.

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opened about the same time, was near Belleville, in St. Clair County, opposite the present site of St. Louis. The outcrops of coal in the bluffs along the river banks first attracted attention, and naturally the first mining operations were started on these exposures. The earliest recorded production was in 1833, when an output of 6,000 tons is said to have been mined.

The production of coal in Illinois from 1833 to the close of 1913 is shown in the following table:

Production of coal in Illinois, 1833–1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1833	6,000	1854	365,000	1875	4,453,178	1896	19,786,626
1834	7,500	1855	400,000	1876	5,000,000	1897	20,072,758
1835	8,000	1856	410,000	1877	5,350,000	1898	18,599,299
1836	10,000	1857	450,000	1878	5,700,000	1899	24,439,019
1837	12,500	1858	490,000	1879	5,000,000	1900	25,767,981
1838	14,000	1859	530,000	1880	6,115,377	1901	27,331,552
1839	15,033	1860	728,400	1881	6,720,000	1902	32,939,373
1840	16,967	1861	670,000	1882	9,115,653	1903	36,957,104
1841	35,000	1862	780,000	1883	12,123,456	1904	36,475,060
1842	58,000	1863	890,000	1884	12,208,075	1905	38,434,363
1843	75,000	1864	1,000,000	1885	11,834,459	1906	41,480,104
1844	120,000	1865	1,260,000	1886	11,175,241	1907	51,317,146
1845	150,000	1866	1,580,000	1887	12,423,066	1908	47,659,690
1846	165,000	1867	1,800,000	1888	14,328,181	1909	50,904,990
1847	180,000	1868	2,000,000	1889	12,104,272	1910	45,900,246
1848	200,000	1869	1,854,000	1890	15,202,420	1911	53,679,118
1849	260,000	1870	2,624,163	1891	15,660,098	1912	59,885,226
1850	300,000	1871	3,000,000	1892	17,862,276	1913	61,618,744
1851	320,000	1872	3,360,000	1893	19,949,564		
1852	340,000	1873	3,920,000	1894	17,113,576	Total	965,516,323
1853	375,000	1874	4,203,000	1895	17,735,964		

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Total production in 1913, 17,165,671 short tons; spot value, $19,001,881.

Although the coal production of Indiana in 1913 showed an increase of 1,879,953 short tons, or 12.3 per cent over 1912, it fell short of the record output of 1910 by more than 1,200,000 tons and was far from satisfactory to the producers. The year was ushered in with weather mild as spring and the remainder of the winter was so unseasonally warm that the consumption of coal for both domestic and steam purposes was considerably subnormal. The flood which swept over that part of the country in March and April caused a suspension of mining operations in some sections of the State lasting from 10 days to two weeks, and seriously handicapped operations at some mines for even a longer period. The flood was immediately followed by a drought during which the water supply in the mining districts all over the State was exhausted, necessitating the shipment of water to the mines, which caused boiler trouble and materially increased the operating expenses. In addition to all of this, there was a general decline in prices throughout the State, the average value per ton showing a decline from $1.14 in 1912 to $1.11 in 1913. The total value increased from $17,480,546 to $19,001,881, a gain of $1,521,335, or 8.7 per cent, as compared with the increase of 12.3 per cent in quantity.

Out of the 19 coal-producing counties in the State, 11 showed decreased production in 1913 and 8 increases. The decreases were

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generally in the less important counties, only one of the large producers, Sullivan County, having a smaller production in 1913 than in 1912, and in that county the decrease was less than 7,000 tons. The principal gains were in Vigo County, 673,228 tons; Knox County, 548,152 tons; and Vermilion County, 538,185 tons. Clay County, whose production has decreased annually since 1910, suffered the largest decrease in 1913—135,366 tons.

In spite of the adverse conditions which prevailed in 1913, labor was in better supply and the number of working days made by the employees was greater than in 1912. The total number of employees in the coal mines of Indiana increased from 21,651 in 1912 to 22,235 in 1913, and the average working time, from 182 to 190 days. The average annual production per man increased from 706 to 772 tons, and the average daily production by each man, from 3.88 to 4.06 tons.

The increased efficiency was due in part to the larger proportion of the product being mined by the use of machines, the increase in that item contributing two-thirds of the total increase, or 1,373,666 tons. The production of machine-mined coal in 1913 amounted to 9,737,425 short tons, or 57 per cent of the total, as compared with 8,363,759 tons, or 54.7 per cent, in 1912. There was not, however, any decrease in the proportion of the product shot off the solid, the figures being 4,615,580 tons in 1912 and 5,175,229 tons in 1913, and the percentage being the same in both years. The quantity of hand-mined coal decreased from 2,094,397 tons, or 13.7 per cent, in 1912 to 1,862,729 tons, or 11 per cent, in 1913. The method employed in mining 2 per cent of the production in 1913 was not reported. The number of mining machines in use increased from 687 in 1912 to 732 in 1913. Chain-breast machines are in the majority, 365, or something over half in 1913 being of that type. Of the remainder, 166 were punchers, 105 were long wall, and 96 were short wall or continuous cutters.

The number of fatal accidents reported to the Bureau of Mines for 1913 was 66, an increase from 40 in 1912. Of the 66 fatalities, 59 were underground, 5 in shafts, and 2 on the surface. Falls of roof and coal claimed 29 victims; gas and dust explosions, 15; and mine cars and locomotives, 8. The death rate per thousand was 2.97, against 1.85 in 1912, and the quantity of coal mined for each lost life was 260,086 tons, against 382,143 tons.

Strikes and suspensions were not of a serious character and resulted in the loss of an average of 17 days by the 2,657 men affected. The total time lost was only a little more than 1 per cent of the time made.

The statistics of coal production in 1913 and 1912, by counties, in Indiana, with the distribution of the product for consumption, are shown in the following table:

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Coal production of Indiana in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Clay	636,236	37,331	26,756	700,323	$949,270	$1.36	164	1,365
Daviess	83,395	19,056	2,628	105,079	150,931	1.44	205	215
Dubois and Martin	.....	16,500	.....	16,500	21,675	1.31	278	18
Fountain and Warren	.....	5,066	.....	5,066	10,480	2.07	195	19
Gibson	189,763	33,075	5,719	228,557	267,632	1.17	195	255
Greene	2,537,194	42,182	57,133	2,636,509	3,080,437	1.17	199	2,984
Knox	1,160,560	24,866	27,170	1,212,596	1,256,293	1.04	196	1,258
Owen	26,787	3,000	920	30,707	47,585	1.55	186	53
Parke	475,972	26,461	20,717	523,150	684,087	1.31	184	865
Perry	.....	15,904	.....	15,904	19,344	1.22	239	30
Pike	521,123	23,147	15,067	559,337	638,826	1.14	190	860
Spencer	2,597	7,703	6	10,306	15,152	1.47	210	20
Sullivan	2,968,371	43,233	79,764	3,091,368	3,428,248	1.11	179	4,419
Vanderburg	103,630	188,254	10,190	302,074	403,250	1.33	183	499
Vermillion	1,479,182	21,046	46,898	1,547,126	1,653,789	1.07	165	2,370
Vigo	3,363,229	106,053	94,764	3,564,046	4,055,879	1.14	183	5,511
Warrick	631,647	45,757	14,071	691,475	732,630	1.06	166	910
Small mines	.....	45,595	.....	45,595	65,038	1.43	.....	.....
Total	14,179,686	704,229	401,803	15,285,718	17,480,546	1.14	182	21,651

1913.

Clay	503,663	32,352	28,942	564,957	$746,940	$1.32	165	1,317
Daviess	71,411	6,634	5,985	84,030	108,826	1.30	207	160
Dubois and Martin	5,550	2,198	200	7,948	12,563	1.58	164	21
Fountain and Warren	55,000	7,202	2,700	64,902	83,930	1.29	156	90
Gibson	162,053	58,994	6,053	227,100	249,513	1.10	199	305
Greene	2,668,439	42,877	69,392	2,780,708	3,041,689	1.09	198	3,137
Knox	1,677,295	46,533	36,920	1,760,748	1,820,017	1.03	203	1,395
Owen	119,258	2,200	5,825	127,283	140,089	1.10	181	120
Parke	472,626	16,534	18,348	507,508	601,127	1.18	197	941
Perry	.....	14,910	.....	14,910	22,649	1.52	255	37
Pike	550,899	19,912	12,826	583,637	652,648	1.12	186	912
Spencer	.....	8,429	50	8,479	12,037	1.42	225	22
Sullivan	2,955,243	42,751	86,425	3,084,419	3,390,749	1.10	159	4,376
Vanderburg	140,892	132,913	6,717	280,522	363,572	1.30	196	459
Vermillion	1,999,539	19,617	66,155	2,085,311	2,313,090	1.11	212	2,484
Vigo	4,023,703	109,951	103,620	4,237,274	4,653,657	1.10	203	5,556
Warrick	628,714	38,096	18,210	685,020	705,894	1.03	179	903
Small mines	.....	60,915	.....	60,915	82,491	1.35	.....	.....
Total	16,034,285	663,018	468,368	17,165,671	19,001,881	1.11	190	22,235

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In the following table are shown the statistics of the production of coal in Indiana, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912:

Coal production of Indiana, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Clay	958,732	980,016	779,372	700,323	564,957	− 135,366
Daviess	73,877	87,374	79,466	105,079	84,030	− 21,049
Dubois	[a] 35,404	[a] 8,290	[a] 4,119	[a] 16,500	[a] 7,948	− 8,552
Fountain	5,520	3,300	1,700	1,100	60,200	+ 59,100
Gibson	232,599	296,753	247,128	228,557	227,100	− 1,457
Greene	2,612,686	3,439,002	2,563,366	2,636,509	2,780,708	+ 144,199
Knox	642,727	1,003,909	879,323	1,212,596	1,760,748	+ 548,152
Owen	15,904	10,690	22,693	30,707	127,283	+ 96,576
Parke	730,082	764,115	521,567	523,150	507,508	− 15,642
Perry	15,603	26,317	16,683	15,904	14,910	− 994
Pike	447,122	697,385	467,623	559,337	583,637	+ 24,300
Spencer	11,118	9,096	9,551	10,306	8,479	− 1,827
Sullivan	3,227,515	4,035,934	3,261,787	3,091,368	3,084,419	− 6,949
Vanderburg	271,644	398,293	279,109	302,074	280,522	− 21,552
Vermilion	1,443,099	1,635,623	1,673,621	1,547,126	2,085,311	+ 538,185
Vigo	3,562,534	4,181,799	2,793,352	3,564,046	4,237,274	+ 673,228
Warren	7,130	5,122	3,925	3,966	4,702	+ 736
Warrick	488,194	768,706	545,132	691,475	685,020	− 6,455
Small mines	52,769	38,091	51,838	45,595	60,915	+ 15,320
Total	14,834,259	18,389,815	14,201,355	15,285,718	17,165,671	+ 1,879,953
Total value	$15,154,681	$20,813,659	$15,326,808	$17,480,546	$19,001,881	+$1,521,335

[a] Includes Martin County.

All of the coal productive area of Indiana is in the southwestern part of the State, which constitutes the eastern edge of the eastern interior coal region. The total area embraces about 6,500 square miles and includes 26 counties, from 19 of which coal is being produced at the present time. Coal of workable thickness has been found at eight different horizons. All of the coal is classed as bituminous. Along the eastern edge of the field is a series of basins, some of which are but a few acres in area, which produce a variety of coal known as block or semiblock, from the almost perfectly rectangular blocks into which it fractures. This is a very pure, dry, noncoking coal, suitable for use in its raw state as a blast-furnace fuel, though usually mixed with coke when so used. The rest of the coals, designated locally as "bituminous" are excellent steam fuels. Some of them possess coking qualities but not sufficiently to compete with those of the Eastern States. Cannel coal is mined at several places. The "bituminous" coals are much more regular and persistent over large areas, some of them being traced with certainty over several thousand square miles of territory. The beds range from 3 to 10 feet in thickness and most of the mines are working on 5 feet or more of coal. Some of the mines, most of which are operated by shaft, are working on three different beds.

Some knowledge of the coal resources of Indiana was obtained as early as 1804, when the public-land surveys showed a number of outcrops. The report of the geological survey of Indiana, published in 1872, states that in 1811 coal was dug at Fulton, in Perry County, and taken by Robert Fulton aboard the steamer, *Orleans* on its first trip down Ohio River. There is good reason to believe that coal continued to be mined for local consumption between 1811 and 1837,

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when the first attempt at commercial mining was made; but there is no record of the quantity mined during that interim. The first commercial coal mining in Indiana was by the American Cannel Coal Co., at Cannelton, Perry County, in 1837. The coal was mined on the bluffs along Ohio and Wabash rivers, and for the first 10 years of the company's operations was loaded directly into boats for shipment down the Ohio.

In 1840 the United States Census reported that the production of coal in Indiana in that year was 9,682 tons. The industry developed slowly until 1865, when it was ascertained that the block coal mined in the Brazil and Terre Haute districts made a satisfactory blast-furnace fuel in its raw condition. At about that time the construction of railroads throughout the State gave an impetus to the coal-mining industry which has shown steady progress except when interrupted by periods of depression and labor disaffections.

The statistics of coal production in Indiana from 1840 to the close of 1913 are given in the following table, the years for which no official statistics are available having been estimated from the best information obtainable:

Production of coal in Indiana from 1840 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	9,682	1859	95,000	1878	1,000,000	1897	4,151,169
1841	10,000	1860	101,280	1879	1,196,490	1898	4,920,743
1842	18,000	1861	128,000	1880	1,454,327	1899	6,006,523
1843	25,000	1862	150,000	1881	1,984,120	1900	6,484,086
1844	30,000	1863	200,000	1882	1,976,470	1901	6,918,225
1845	35,000	1864	250,000	1883	2,560,000	1902	9,446,424
1846	40,000	1865	280,000	1884	2,260,000	1903	10,794,692
1847	45,000	1866	320,000	1885	2,375,000	1904	10,842,189
1848	50,000	1867	350,000	1886	3,000,000	1905	11,895,252
1849	56,000	1868	375,000	1887	3,217,711	1906	12,092,560
1850	60,000	1869	400,000	1888	3,140,979	1907	13,985,713
1851	60,000	1870	437,870	1889	2,845,057	1908	12,314,890
1852	75,000	1871	600,000	1890	3,305,737	1909	14,834,259
1853	75,000	1872	896,000	1891	2,973,474	1910	18,389,815
1854	80,000	1873	1,000,000	1892	3,345,174	1911	14,201,355
1855	80,000	1874	812,000	1893	3,791,851	1912	15,285,718
1856	85,000	1875	800,000	1894	3,423,921	1913	17,165,671
1857	85,000	1876	950,000	1895	3,995,892		
1858	87,000	1877	1,000,000	1896	3,905,779	Total	251,632,098

IOWA.

Total production in 1913, 7,525,936 short tons; spot value, $13,496,710.

Compared with 1912, when the production of coal in Iowa amounted to 7,289,529 short tons, valued at $13,152,088, the record for 1913 showed an increase of 236,407 tons, or 3.24 per cent in quantity and of $344,622, or 2.62 per cent in value. Except for the drought, which began in June and did not end until September, conditions during the year were normal. The slight increase in production over 1912 was due to the disturbed labor situation in Colorado. Operators complain of the unsatisfactory character of the mine labor in the State, not so much on account of inefficiency as of exacting demands which they claim have increased the cost of mining beyond the prices they have been able to secure for their product and have discouraged the opening and development of new properties. Iowa is primarily an agricultural State and the markets for its coal, outside

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of that taken by the railroads, are chiefly in rural communities and cities of moderate size dependent upon agricultural trade. There are no extensive manufacturing interests requiring large supplies of fuel for power purposes. Some coal is shipped to Nebraska, Minnesota, and other States, but an equal quantity comes into Iowa from Illinois and eastern fields. The coal beds of the State are not thick, the thickest in the Des Moines district averaging about 5 feet, and they are somewhat irregular and faulted. The coal is of noncoking bituminous grade, somewhat high in sulphur, but is a fair steaming fuel. In the Centerville district the coal is regular and persistent, but thin, being not over 30 inches in thickness. It has, however, a strong roof that furnishes ideal conditions for long-wall mining. Mining operations are all on a moderate scale, there being only 6 mines producing over 200,000 tons, and 18 having an output of over 100,000 tons in 1913.

Coal was mined on a commercial scale in 21 counties in 1913, 1 less than in 1912—Scott County, which had a small production in 1912, not reporting any output in 1913. Of the 21 counties, 12 showed decreased production in 1913, and in 9 the production increased. The principal decrease in 1913 was in Mahaska County, whose output has declined each year since 1909. The decline in that county in 1913 was 223,106 tons, or nearly 40 per cent. The principal gains were in Dallas County, 137,980 tons; Monroe County, 177,865 tons; and Marion County, 116,484 tons. Marion County's production in 1913 was 64 per cent larger than in 1912. Dallas County continued an uninterrupted sequence of increases since 1906, reversing the conditions shown in Mahaska County.

The number of men employed in the coal mines of Iowa decreased from 16,370 in 1912 to 15,757 in 1913, but notwithstanding this shortage and the larger production of coal in 1913, the average number of working days showed only a slight increase from 188 to 195. There was, in consequence, an increase in the average yearly production per man from 445 tons to 478 tons, and in the average daily production from 2.37 to 2.45 tons.

Iowa is no exception to the other States of the interior province where shooting off coal from the solid is practised to a reprehensible degree, and the record in that respect for 1913 was worse than in 1912. The quantity of coal shot off the solid in 1913 was 5,440,437 short tons, or 72.3 per cent of the total; in 1912 69 per cent of the total was "powder-mined." There were 28 machines reported in use in 1913, but only 120,716 tons of coal were machine-mined. Of the machines in use, 3 were punchers, 7 were chain-breast, 8 were long-wall, 8 were short-wall, and 2 were radialaxe. The quantity of coal mined by hand was 1,523,655 tons, or 20.2 per cent of the total. The methods used in mining 441,128 tons, or nearly 6 per cent of the total, were not reported.

There were 7 instances of labor strikes during the year. The total number of men on strike was 721, and the average time lost by each was 19 days.

Little attempt is made in Iowa to improve the quality of the coal by washing. In 1913 the total quantity of coal washed was 31,711 tons, which yielded 22,080 tons of cleaned coal, and 9,631 tons of refuse.

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According to reports of the Bureau of Mines, there were 26 fatal accidents in the coal mines of Iowa in 1913, an increase of 7 over 1912. All of the fatalities occurred underground, and 18 of them were due to falls of roof. Six deaths were due to haulage-way accidents. The death rate per thousand was 1.65 against 1.16 in 1912, and the quantity of coal mined for each life lost was 289,459 tons, as compared with 383,659 tons in 1912.

The statistics of coal production in Iowa in 1912 and 1913, by counties, with the distribution of the product for consumption, are shown in the following table:

Coal production of Iowa in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adams	.....	9,868	.....	9,868	$24,690	$2.50	124	55
Appanoose	1,168,776	65,969	17,921	1,252,666	2,506,844	2.00	161	4,166
Boone	172,585	35,683	3,900	212,168	454,731	2.14	161	776
Dallas	420,990	8,969	6,247	436,206	810,532	1.86	225	957
Greene	90	9,500	.....	9,590	24,250	2.53	158	32
Guthrie	.....	5,870	.....	5,870	16,191	2.76	201	28
Jasper	237,221	19,530	14,550	271,301	669,936	2.47	212	584
Jefferson	.....	4,248	.....	4,248	9,170	2.16	170	16
Keokuk	.....	14,240	50	14,290	26,733	1.87	153	31
Mahaska	546,100	20,669	12,074	578,843	944,156	1.63	211	983
Marion	161,655	16,434	3,979	182,068	315,260	1.73	191	428
Monroe	2,272,558	48,297	72,457	2,393,412	3,757,856	1.57	206	4,281
Polk	1,226,294	221,240	38,519	1,486,053	2,761,723	1.86	187	2,912
Taylor	2,600	2,520	.....	5,120	12,700	2.48	155	31
Van Buren	5,600	3,529	25	9,154	18,785	2.05	221	14
Wapello	175,031	25,877	5,194	206,102	345,324	1.68	203	488
Wayne	87,387	10,631	1,150	99,168	205,182	2.47	159	377
Webster	42,320	3,054	2,700	48,074	107,088	2.23	196	151
Other counties [a] and small mines	.....	64,078	1,250	65,328	140,937	2.16	180	60
Total	6,519,307	590,206	180,016	7,289,529	13,152,088	1.80	188	16,370

1913.

Adams	.....	6,971	.....	6,971	$17,536	$2.52	182	48
Appanoose	1,130,383	64,104	12,900	1,207,387	2,436,279	2.02	170	4,186
Boone	216,189	35,243	4,780	256,212	522,929	2.04	179	754
Dallas	546,832	8,348	19,006	574,186	1,077,293	1.88	245	889
Guthrie	.....	4,492	.....	4,492	11,890	2.65	147	29
Jasper	255,200	8,867	3,500	267,567	567,211	2.12	156	800
Mahaska	327,655	21,748	6,334	355,737	568,314	1.60	199	698
Marion	276,064	16,249	6,239	298,552	487,151	1.63	193	581
Monroe	2,457,050	50,226	64,001	2,571,277	4,087,032	1.59	215	4,138
Polk	1,345,237	213,296	42,482	1,601,015	2,984,919	1.86	212	2,591
Van Buren	6,000	8,381	.....	14,381	32,772	2.28	224	29
Wapello	124,845	25,969	2,891	153,705	259,099	1.69	240	309
Wayne	73,215	11,760	800	85,775	172,531	2.01	193	253
Webster	42,373	1,553	1,750	45,676	101,078	2.21	215	130
Other counties [b] and small mines.	23,890	57,963	1,150	83,003	170,676	2.06	81	322
Total	6,824,933	535,170	165,833	7,525,936	13,496,710	1.79	195	15,757

[a] Lucas, Page, Scott, and Warren.
[b] Greene, Jefferson, Keokuk, Lucas, Page, Taylor, and Warren.

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The production, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912, is shown in the following table:

Coal production of Iowa, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase (+) or decrease (−), 1913.
Adams	13,194	12,745	7,472	9,868	6,971	− 2,897
Appanoose	1,236,009	1,413,896	1,104,723	1,252,666	1,207,387	− 45,279
Boone	275,711	275,882	214,440	212,168	256,212	+ 44,044
Dallas	244,219	255,085	385,588	436,206	574,186	+ 137,980
Greene	9,700	10,150	11,800	9,590	9,600	+ 10
Guthrie	6,730	17,324	10,390	5,870	4,492	− 1,378
Jasper	323,092	349,063	292,427	271,301	267,567	− 3,734
Jefferson	6,255	7,530	5,129	4,248	3,000	− 1,248
Keokuk	14,430	13,141	12,512	14,290	4,404	− 9,886
Lucas	9,326	11,233	13,337	15,459	27,904	+ 12,445
Mahaska	926,438	848,199	777,189	578,843	355,737	− 223,106
Marion	329,353	215,281	171,329	182,068	298,552	+ 116,484
Monroe	2,025,559	2,184,030	2,259,239	2,393,412	2,571,277	+ 177,865
Page	16,134	10,550	12,396	5,050	1,250	− 3,800
Polk	1,788,129	1,778,264	1,532,010	1,486,053	1,601,015	+ 114,962
Scott	8,400	400	.....	300	.....	− 300
Taylor	13,536	9,749	9,950	5,120	6,223	+ 1,103
Van Buren	15,965	10,284	8,656	9,154	14,381	+ 5,227
Wapello	261,520	283,500	312,332	206,102	153,705	− 52,397
Warren	16,201	1,992	1,500	3,595	3,430	− 165
Wayne	128,004	135,439	116,382	99,168	85,775	− 13,393
Webster	66,584	49,973	46,026	48,074	45,676	− 2,398
Other counties and small mines	24,283	34,410	[a] 26,821	[a] 40,924	[a] 27,192	− 13,732
Total	7,757,762	7,928,120	7,331,648	7,289,529	7,525,936	+ 236,407
Total value	$12,793,628	$13,903,913	$12,663,507	$13,152,088	$13,496,710	+$344,622

[a] Small mines only.

The coal fields of Iowa constitute the northern limits of the western interior region and occupy the central and southern portions of the State. They have a total area of approximately 20,000 square miles, of which about 13,000 square miles are considered as workable under present conditions, and most of the remainder possess possibilities for the future.

The more important producing areas are: (1) The northern, including Webster, Boone, and neighboring counties, and yielding 4 per cent of the total output; (2) the north central, including Polk, Jasper, and Dallas counties, and producing 29 per cent of the output, chiefly from Polk County; (3) the south central, including Marion, Mahaska, Monroe, and adjacent counties, and producing 43 per cent of the total output; (4) the southeastern, including Wapello, Van Buren, and adjacent counties, and yielding 4 per cent of the total (in all of these areas practically all of the coal mined comes from the lower part of the Des Moines group); (5) the south central, including Appanoose and Wayne counties, produces 19 per cent of the State's total (the coal mined is from the Mystic or Centerville bed); (6) the southwestern, including Adams, Taylor, and Page counties, yields one-half of 1 per cent of the total. This product is from the Nodaway bed of the Missouri group.

Iowa probably ranks second among the States west of the Mississippi River in order of priority as a coal producer. At the time of taking the United States census for 1840 Iowa and Missouri were the only States west of the Mississippi in which any coal production was reported. Missouri, however, was credited with an output of nearly

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10,000 tons, and Iowa's production was given at 400 tons. It is probable, therefore, that the first mine opened in Missouri antedated Iowa's initial production. The production of coal in Iowa since 1840 will be found in the following table, estimates being given for years for which no official figures are available:

Production of coal in Iowa, 1840 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	400	1859	42,000	1878	1,350,000	1897	4,611,865
1841	500	1860	41,920	1879	1,400,000	1898	4,618,842
1842	750	1861	50,000	1880	1,461,116	1899	5,177,479
1843	1,000	1862	53,000	1881	1,960,000	1900	5,202,939
1844	2,500	1863	57,000	1882	3,920,000	1901	5,617,499
1845	5,000	1864	63,000	1883	4,457,540	1902	5,904,766
1846	6,500	1865	69,574	1884	4,370,566	1903	6,419,811
1847	8,000	1866	99,320	1885	4,012,575	1904	6,519,933
1848	10,000	1867	150,000	1886	4,315,779	1905	6,798,609
1849	12,500	1868	241,453	1887	4,473,828	1906	7,266,224
1850	15,000	1869	295,105	1888	4,952,440	1907	7,574,322
1851	18,000	1870	263,487	1889	4,095,358	1908	7,161,310
1852	20,000	1871	300,000	1890	4,021,739	1909	7,757,762
1853	23,000	1872	336,000	1891	3,825,495	1910	7,928,120
1854	25,000	1873	392,000	1892	3,918,491	1911	7,331,648
1855	28,000	1874	799,936	1893	3,972,229	1912	7,289,529
1856	30,000	1875	1,231,547	1894	3,967,353	1913	7,525,936
1857	33,000	1876	1,250,000	1895	4,156,074		
1858	37,500	1877	1,300,000	1896	3,954,028	Total	186,603,097

KANSAS.

Total production in 1913, 7,202,210 short tons; spot value, $12,036,292.

Coal-mine operators in Kansas had little of which to complain in 1913. There was no serious trouble with labor, although there were some local strikes due to minor misunderstandings, but they were not of long duration. Railroad consumption increased somewhat on account of the strike in the Colorado mines, transportation facilities were satisfactory, and the demand for steam coal for manufacturing and for domestic fuel was generally well up to the supply. The only unfavorable instances were occasional shutdowns at the stripping operations and some inconvenience during the drought in the summer and early fall, when boiler water had to be hauled to the mines. Neither of these, however, caused serious interference with the mining operations. The output increased from 6,986,182 short tons, valued at $11,324,130, in 1912 to 7,202,210 tons, valued at $12,036,292 in 1913, the increase amounting to 216,028 tons, or 3.1 per cent in quantity, and $712,162, or 6.3 per cent in value. The average value per ton advanced from $1.62 to $1.67.

Shooting from the solid continues to be practiced in the coal mines of Kansas to a reprehensible extent, although there was a slight improvement in that regard in 1913. The coal mined by that method was 5,796,689 short tons, or 80.5 per cent of the total, compared with 5,864,226 tons, or 83.9 per cent of the total, in 1912. Machine mining has not made much progress in the State, the quantity so produced in 1913 being less than 25,000 tons. The coal reported as mined by hand was 1,068,039 tons, or 14.8 per cent of the total, and there were 315,362 tons for which the method of mining was not reported. A small percentage of the product, 48,423 tons, was washed, yielding 39,343 tons of cleaned coal and 9,080 tons of refuse.

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The number of men employed in the coal mines of Kansas in 1913 was 12,479, and they worked an average of 197 days, against 11,646 men for an average of 202 days in 1912. The average production per man was 577 tons for the year and 2.93 tons for each working day in 1913, compared with 600 tons for the year and 2.97 tons per day in 1912.

The number of fatal accidents reported to the Bureau of Mines in 1913 was 28, the same as in 1912, but as the number of men employed and the quantity of coal produced were both larger in 1913 than in the preceding year, the death rate was slightly less (2.24 against 2.4), and the quantity of coal mined for each life loss slightly more (257,222 tons, against 249,507 tons).

The statistics of the production of coal in Kansas in 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

Coal production of Kansas in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Cherokee	2,256,917	23,635	52,392	.....	2,332,944	$3,821,196	$1.64	207	3,436
Crawford	4,114,461	41,025	99,929	.....	4,255,415	6,569,751	1.54	202	6,759
Leavenworth	145,442	19,145	39,161	775	204,523	445,597	2.18	221	682
Linn	23,978	8,760	850	.....	33,588	65,205	1.94	198	94
Osage	121,476	14,062	258	.....	135,796	367,176	2.70	171	660
Other counties[a] and small mines	560	23,351	5	.....	23,916	55,205	2.31	129	15
Total	6,662,834	129,978	192,595	775	6,986,182	11,324,130	1.62	202	11,646

1913.

Cherokee	2,192,766	21,802	44,451	.....	2,259,019	$3,740,324	$1.66	204	3,385
Crawford	4,464,565	46,020	103,672	.....	4,614,257	7,513,732	1.63	197	7,656
Leavenworth	116,774	11,900	32,535	.....	161,209	375,285	2.33	210	726
Linn	22,341	2,121	750	.....	25,212	42,628	1.69	136	91
Franklin and Osage	106,841	10,473	212	.....	117,526	309,939	2.64	153	622
Small mines	.....	24,987	.....	.....	24,987	54,384	2.18	.....	.....
Total	6,903,287	117,303	181,620	.....	7,202,210	12,036,292	1.67	197	12,479

[a] Franklin and Neosho.

Crawford County, which produces about two-thirds of the total output, was the only county which showed any material increase in 1913. The gain in output was 358,842 tons. Cherokee County, the second in importance, with about 3 per cent of the total production, showed a decrease of 73,925 tons, and Leavenworth County's production decreased 43,314 tons.

The statistics of production, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912, are shown in the following table:

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Coal production of Kansas, 1909–1913, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Cherokee	2,201,947	1,477,525	2,036,052	2,332,944	2,259,019	− 73,925
Cloud	800	800				
Crawford	4,328,012	2,986,411	3,778,242	4,255,415	4,614,257	+ 358,842
Franklin	3,160	2,000	2,400	725	1,716	+ 991
Leavenworth	321,132	275,377	206,049	204,523	161,209	− 43,314
Linn	8,544	24,298	27,366	33,588	25,212	− 8,376
Osage	100,197	116,769	104,479	135,796	115,810	− 19,986
Other counties and small mines	22,686	38,271	24,140	23,191	24,987	+ 1,796
Total	6,986,478	4,921,451	6,178,728	6,986,132	7,202,210	+ 216,028
Total value	$10,083,384	$7,914,709	$9,473,572	$11,324,130	$12,036,292	+$712,162

The coal-productive area of Kansas lies entirely in the eastern part of the State. The coal measures underlie approximately 20,000 square miles, of which about three-fourths may be considered as probably productive. Three fields or districts have been fairly well developed. The most important of them is the Cherokee and Crawford County field in the southeast corner of the State. Over 90 per cent of the total production of the Kansas mines is from these two counties. The principal coal bed in the district, the Cherokee, varies from 3 to 10 feet in thickness, though the average is only about 3½ feet. The coal is bituminous, of good quality, and roof and floor conditions are excellent. Some of the coal beds lie near the surface, and mining operations are carried on by removing the overburden and "stripping" the coal. Some of this coal, because of its absolute freedom from coking tendency, is known locally as "dead" coal and is used raw by the zinc smelters in and near Pittsburgh.

The second district in importance is that adjacent to Leavenworth and Atchison, in the northeast corner of the State, where at a depth of from 700 to 1,500 feet a thin bed is found and is mined "longwall." It is the only district in which deep mining is carried on in the Western Interior coal field. A considerable portion of the production from the shaft at Leavenworth is mined on the Missouri side of the river. In the earlier reports of this series it has been customary to credit all of the production to Kansas, as the opening is in that State, but for the last three years the tonnage taken from the Missouri side has been reported separately and has been credited to that State.

The third district is in the eastern central part of the State, chiefly in Osage County. The bed mined in this district is only 22 inches thick, but lies at comparatively shallow depth. There are more mines in Osage County than in the other two districts combined, but they are relatively small and are worked chiefly for comparatively local consumption.

The earliest record of coal production in Kansas shows that the State produced in 1869 a total of 36,891 tons. From 1870 to 1880 the production has been estimated from the best information obtainable, and since 1882 it has been collected by the statistical division of the United States Geological Survey, as shown in the following table, giving the annual production of coal in Kansas from 1869 to 1913, inclusive.

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Production of coal in Kansas, 1869 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1869	36,891	1881	840,000	1893	2,652,546	1905	6,423,979
1870	32,938	1882	750,000	1894	3,388,251	1906	6,024,775
1871	41,000	1883	900,000	1895	2,926,870	1907	7,322,449
1872	44,800	1884	1,100,000	1896	2,884,801	1908	6,245,508
1873	56,000	1885	1,212,057	1897	3,054,012	1909	6,986,478
1874	85,000	1886	1,400,000	1898	3,406,555	1910	4,921,451
1875	150,000	1887	1,596,879	1899	3,852,267	1911	6,178,728
1876	225,000	1888	1,850,000	1900	4,467,870	1912	6,986,182
1877	300,000	1889	2,221,043	1901	4,900,528	1913	7,202,210
1878	375,000	1890	2,259,922	1902	5,266,065		
1879	460,000	1891	2,716,705	1903	5,839,976	Total	129,696,761
1880	771,442	1892	3,007,276	1904	6,333,307		

KENTUCKY.

Total production in 1913, 19,616,600 short tons; spot value, $20,516,749.

Kentucky is one of the 12 States that in 1913 established new records in the quantity and value of their coal production, and in one respect—the percentage of increase—Kentucky outclassed not only her 11 record-making sister States, but all of the States with the single exception of California, whose total production was less than 25,000 tons. The production of coal in Kentucky increased from 16,490,521 short tons, valued at $16,854,207 in 1912, to 19,616,600 tons, valued at $20,516,749 in 1913. The increase in quantity amounted to 3,126,079 short tons, or 19 per cent, and the value increased $3,662,542, or 21.7 per cent. The nearest approach to these rates of increase among the other States whose production exceeded 5,000,000 tons was in Virginia, whose output increased 12.5 per cent in quantity and 19 per cent in value. Nearly 80 per cent of the increase in Kentucky's production in 1913 was in the eastern counties. Letcher County led with an increase of over 900,000 tons; Pike County was a good second, with a gain of 717,579 tons; Harlan County was third in quantity of increase, showing a gain of 417,875 tons; and Bell County was fourth, with a addition of 288,461 tons. The total increase in the eastern part of the State was 2,481,767 tons, and the western counties showed a total gain of 644,312 tons. The principal increases in the western part of the State were in Muhlenberg County, 265,234 tons, and in Webster County, 222,179 tons. Until 1912 the larger portion of the production in Kentucky was from the western counties, but increases aggregating more than 4,200,000 tons in the eastern counties during the last two years have given the supremacy to that portion of the State. In 1913 the production of coal in the eastern counties exceeded that in the western district by more than 2,500,000 tons.

The average value per ton advanced from $1.02 in 1912 to $1.05 in 1913. The latter figure has been exceeded only twice in the last 25 years, in 1903 and in 1907, in both of which years the average value per ton was $1.06.

The number of men employed in the coal mines of Kentucky increased from 24,304 in 1912 to 26,332 in 1913, and the average working time from 201 to 212 days, the total working time showing an increase of 14 per cent, as compared with an increase of 19 per cent

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in production. This average production by each man employed was 745 tons in 1913 against 679 tons in 1912 and 640 tons in 1911. The average daily production per man increased from 3.18 tons in 1911 to 3.38 in 1912 and to 3.51 tons in 1913.

The increase in individual production was due in large part, if not entirely, to the more extended use of mining machines, Kentucky in the percentage of machine-mined tonnage to the total output ranking next to Ohio and second among all the States. The quantity of coal mined by the use of machines increased from 10,954,648 tons, or 66.4 per cent of the total, in 1912 to 14,353,583 tons, or 73.2 per cent of the total, in 1913. The increase in the output by machines was 3,398,935 tons, or 272,856 tons more than the total increase in the State. The number of machines in use increased from 1,168 in 1912 to 1,263 in 1913. Of the machines in use in 1913, 574 were punchers, 377 were chain-breast, 213 were short-wall, 98 were long-wall, and one was a radialaxe. The quantity of coal shot off the solid in 1913 was 3,092,985 tons, an increase from 2,727,399 tons in 1912, but a decrease in percentage of the total from 16.5 to 15.7 per cent. The quantity undercut by hand in 1913 was 1,755,461 tons, or 9 per cent of the total.

Labor troubles in the coal mines of Kentucky were insignificant, both in 1912 and 1913. Only 1,029 mine workers, less than 4 per cent of the total number of men employed ,were on strike in 1913, and the average time lost by them was 18 days. In 1912, 2,759 men were idle on account of strikes or suspensions for an average of 29 days. Notwithstanding the larger number of men employed and the more days worked in 1913 as compared with 1912, there were fewer fatalities reported to the Bureau of Mines, the accidental deaths being reduced by 3 from 51 in 1912 to 48 in 1913. There was no explosion of gas or dust which resulted fatally, and the chief causes of death were falls of roof, just half of the total number of fatalities being due to that type of accident. Five men were suffocated to death in an abandoned mine; 4 were killed by electricity; and 15 deaths were due to miscellaneous causes, one at a time. The death rate per thousand in 1913 was 1.8, and the quantity of coal mined for each life lost was 408,679, one of the best records of the year.

The statistics of production in 1912 and 1913, by counties, with the distribution of the product for consumption, are shown in the following table.

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Coal production of Kentucky, 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bell	2,120,053	29,302	43,222	7,500	2,200,077	$2,382,862	$1.08	209	3,476
Boyd	92,874	6,909	975	.....	100,758	90,829	.90	185	214
Carter	60,237	26,731	365	.....	87,333	78,526	.90	198	189
Christian	54,749	2,225	3,165	.....	60,139	50,517	.84	184	122
Daviess	14,286	73,522	2,217	.....	90,025	101,309	1.13	253	132
Floyd	433,803	5,796	7,175	.....	446,774	504,243	1.13	207	531
Hancock	.....	3,800	.....	.....	3,800	5,700	1.50	134	15
Harlan	184,797	3,979	5,933	137,683	332,392	361,934	1.09	197	483
Henderson	164,396	63,336	8,527	.....	236,159	259,754	1.10	164	438
Hopkins	2,264,491	77,750	126,302	80,170	2,549,113	2,130,462	.84	222	2,983
Johnson	901,477	9,295	20,958	.....	932,230	1,299,033	1.39	217	1,045
Knox	815,463	7,809	17,600	.....	840,872	892,180	1.06	219	1,520
Laurel	210,940	11,562	4,488	.....	226,990	238,493	1.05	197	420
Lawrence	63,145	1,476	2,613	.....	67,234	61,624	.92	171	202
Lee	46,685	679	580	.....	47,744	62,366	1.31	193	124
McCreary	530,448	9,044	4,015	.....	543,307	572,178	1.05	208	1,126
McLean	116,467	3,446	2,218	.....	122,331	110,854	.91	137	251
Morgan	76,312	12,448	1,198	.....	89,958	203,087	2.26	260	267
Muhlenberg	2,278,470	34,515	55,052	.....	2,368,037	2,189,013	.92	160	3,627
Ohio	616,109	22,054	23,223	.....	661,386	586,722	.89	105	1,122
Pike	1,330,515	13,918	27,614	34,115	1,406,462	1,355,596	.96	216	1,582
Union	472,008	48,067	28,915	531	550,421	541,603	.98	181	814
Webster	1,118,056	24,572	28,956	.....	1,172,484	1,046,807	.89	229	1,189
Whitley	971,116	11,533	17,336	.....	999,985	1,287,670	1.29	219	1,986
Other counties a	219,918	9,995	5,731	.....	235,644	280,024	1.19	161	446
Small mines	.....	118,866	.....	.....	118,866	160,821	1.35	.....	.....
Total	15,159,515	632,629	438,378	259,999	16,490,521	16,854,207	1.02	201	24,304

1913.

Bell	2,357,173	79,019	52,346	.....	2,488,538	$2,790,939	$1.12	242	3,721
Boyd	119,178	10,392	1,638	.....	131,208	118,612	.90	237	197
Carter	57,656	52,412	527	.....	110,595	108,307	.98	220	184
Christian	67,160	725	1,640	.....	69,525	68,068	.98	166	160
Daviess	.....	48,398	145	.....	48,543	47,770	.98	252	67
Floyd	437,141	3,313	5,495	.....	445,949	515,472	1.16	217	555
Hancock	.....	6,280	.....	.....	6,280	8,170	1.30	179	14
Harlan	532,235	9,211	8,759	200,062	750,267	922,837	1.23	189	1,014
Henderson	127,634	85,765	7,183	.....	220,582	240,703	1.09	155	361
Hopkins	2,287,435	64,955	102,692	79,739	2,534,821	2,133,964	.84	199	3,008
Johnson	826,127	7,750	27,312	.....	861,189	1,187,661	1.38	204	1,179
Knox	928,895	11,912	20,685	.....	961,492	1,018,566	1.06	222	1,602
Laurel	173,454	16,100	7,015	.....	196,569	251,417	1.28	198	410
Lee	27,761	2,195	196	.....	30,152	46,395	1.54	172	69
Letcher	1,079,554	7,933	17,965	.....	1,105,452	1,377,464	1.25	258	1,143
McCreary	616,924	5,593	2,584	.....	625,101	642,160	1.03	264	1,053
McLean	75,867	5,937	1,525	.....	83,329	70,090	.84	151	197
Morgan	76,230	12,851	1,265	.....	90,346	173,410	1.92	282	225
Muhlenberg	2,553,979	28,050	51,242	.....	2,633,271	2,380,949	.90	180	3,545
Ohio	719,714	27,485	28,346	.....	775,545	683,033	.88	167	1,117
Perry	17,433	7,470	50	.....	24,953	28,165	1.13	109	113
Pike	1,955,611	18,483	37,314	112,633	2,124,041	2,155,837	1.01	239	2,310
Union	583,393	77,174	30,401	.....	690,968	703,530	1.02	195	758
Webster	1,347,016	16,870	30,777	.....	1,394,663	1,211,846	.87	210	1,356
Whitley	990,208	9,747	15,415	.....	1,015,370	1,391,934	1.37	207	1,761
Other counties b	72,048	3,376	2,201	.....	77,625	78,806	1.02	168	213
Small mines	.....	120,226	.....	.....	120,226	160,644	1.34	.....	.....
Total	18,029,826	739,622	454,718	392,434	19,616,600	20,516,749	1.05	212	26,332

a Breathitt, Clay, Greenup, Letcher, Magoffin, Perry, Pulaski, and Rockcastle.
b Breathitt, Clay, Greenup, Lawrence, Letcher, and Pulaski.

Kentucky is the only one of the coal-producing States which has within its borders areas belonging to any two of the great coal fields. The eastern counties of the State are underlain by the coal beds of

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the great Appalachian Mountain system, extending entirely across the State in a northeast-southwest direction, while the southern limits of the central or eastern interior field are found in the more northern counties of the western part of the State. The total area underlain by coal in the eastern counties of Kentucky is estimated at 10,270 square miles, and the coal-bearing areas in the western part of the State are estimated to contain 6,400 square miles, or somewhat more than one-half of that of the eastern part. Up to the close of 1911 the larger part of the production of the State had been from the western district, but as a result of extensive developments in Harlan, Johnson, Letcher, and Pike counties the larger part of the coal production in 1912 and 1913 was from the eastern part of the State. There is little probability of the western district again getting the ascendancy.

Generally speaking, the eastern coal field of Kentucky is a unit, unless the Middlesboro-Harlan portion of it, cut off by the Pine Mountain fault, be excepted. Until 1912 a large part of the field was without railroad facilities, but the construction of the Big Sandy & Elkhorn Railroad by the Baltimore & Ohio Railroad into Pike and Letcher counties, and of the Lexington & Eastern branch of the Louisville & Nashville system into Harlan and Letcher counties, has resulted in the development in eastern Kentucky during 1910, 1911, 1912, and 1913 of probably more absolutely new coal territory than has been opened in the same time in all the rest of the United States. Other railroad construction is in contemplation. Some impression of the effect of this development may be formed from the statement that in 1908 Pike County had a production of 560,000 tons of coal, and in 1913 it produced over 2,000,000 tons; Johnson County produced less than 160,000 tons in 1908 and over 860,000 tons in 1913; Harlan and Letcher counties produced no coal prior to 1910, except from country banks, and in 1913 they had a combined production of over 1,850,000 tons.

The coals of this field belong to the Allegheny formation ("Lower Productive Coal Measures") and to the Pottsville group. The Pottsville, which at Ohio River has a thickness of only a few hundred feet and carries five coals, is in the southeast corner of the State about 5,000 feet thick, and carries nearly 50 coals, of which a dozen or more are locally of workable thickness and quality. The eastern Kentucky coals are mostly high-grade "gas" or "coking" coals, with some cannel coal. In the Jellico coal field the Jellico and the Blue Gem beds are both thin, the latter being successfully mined where averaging only 22 inches. On the other hand, some of the beds show 8 and 9 feet or more of workable coal.

The workable coal of the western district of Kentucky is confined for the most part to two beds, designated as No. 9 and No. 11 by the Geological Survey of Kentucky. Of these, No. 9 (equivalent to No. 5 of the Illinois field) is the more persistent and furnishes probably 75 per cent or more of the total production of the western counties of the State. It underlies the whole or portions of eight counties, including all of the field except its eastern portion and the southern or southwestern edge and a few other places, where it has been cut out by irregularities in the structure, which near the west and south

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borders of the field is seriously affected by faults. The bed has an average thickness of about 5 feet and only rarely thickens out to more than 5 feet 6 inches or thins down to less than 4 feet 6 inches. Over a broad zone it lies within 300 feet below the surface, and the mining is done by shaft. Bed No. 11 lies from 40 to 100 feet above No. 9, and is the next important bed in western Kentucky. It is much more irregular than No. 9, but usually where worked has a thickness of 6 feet or over. Another bed lying about 25 feet above No. 11 is known as No. 12. It is mined in Webster, Hopkins, McLean, and Muhlenberg counties. In the central portion of this field this bed attains a thickness of from 3 to 6 feet. Other beds besides these three are mined at several localities in the district, notably what is supposed to be No. 6 and also No. 5.

In the following table is presented a statement of the production of coal in Kentucky for the last five years, by counties, with increase and decrease in each county in 1913 compared with 1912:

Coal production of Kentucky, 1909 to 1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Bell	1,538,568	2,051,106	2,002,508	2,200,077	2,488,538	+ 288,461
Boyd	86,904	103,051	109,255	100,758	131,208	+ 30,450
Breathitt and Lee	105,091	92,125	57,102	84,180	36,152	− 48,028
Butler	7,228	1,756	1,580			
Carter	81,404	67,400	39,006	87,333	110,595	+ 23,262
Christian, Daviess, and Hancock	121,738	117,286	111,203	153,964	124,348	− 29,616
Floyd		137,330	250,883	446,774	445,949	− 825
Greenup		290	513			
Harlan		1,440	17,860	332,392	750,267	+ 417,875
Henderson	163,782	241,281	223,957	236,159	220,582	− 15,577
Hopkins	1,864,453	2,554,620	2,156,021	2,549,113	2,534,821	− 14,292
Johnson	222,746	468,609	801,464	932,230	861,189	− 71,041
Knox	610,705	654,478	764,601	840,872	961,492	+ 120,620
Laurel	214,251	275,224	242,728	226,990	196,569	− 30,421
Lawrence	96,440	100,895	52,146	67,234	69,157	+ 1,923
Letcher				193,298	1,105,452	+ 912,154
McCreary				543,307	625,101	+ 81,794
McLean	128,015	206,001	122,382	122,331	83,329	− 39,002
Morgan		70,061	75,581	89,958	90,346	+ 388
Muhlenberg	2,009,549	2,738,427	2,243,193	2,368,037	2,633,271	+ 265,234
Ohio	626,158	819,397	769,885	661,386	775,545	+ 114,159
Pike	684,450	953,605	1,136,997	1,406,462	2,124,041	+ 717,579
Pulaski	61,723	85,218	69,437	1,000	1,500	+ 500
Rockcastle		5,000		190		− 190
Union	444,457	590,378	462,683	550,421	690,968	+ 140,547
Webster	449,508	1,026,188	878,466	1,172,484	1,394,663	+ 222,179
Whitley	933,154	1,167,937	1,182,308	999,985	1,015,370	+ 15,385
Other counties and small mines	247,060	94,216	277,944	123,586	146,147	+ 22,561
Total	10,697,384	14,623,319	14,049,703	16,490,521	19,616,600	+ 3,126,079
Total value	$10,079,917	$14,405,887	$14,008,458	$16,854,207	$20,516,749	+$3,662,542

In the following table the statistics of Kentucky's coal production during the last five years are divided according to the counties in the eastern and the western parts of the State. The coal areas in the eastern part of Kentucky belong to the Appalachian region; those in the western district belong to the eastern interior region and form the southern extremity of the Illinois-Indiana field:

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Coal production of the eastern district of Kentucky, 1909–1913, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Bell	1,538,568	2,051,106	2,002,508	2,200,077	2,488,538	+ 288,461
Boyd	86,904	103,051	109,255	100,758	131,208	+ 30,450
Breathitt	20,982	24,432	11,245	36,436	6,000	− 30,436
Carter	81,404	67,400	39,006	87,333	110,595	+ 23,262
Floyd	.....	137,330	250,883	446,774	445,949	− 825
Greenup	.....	290	513	.....	.....	.....
Harlan	.....	1,440	17,860	332,392	750,267	+ 417,875
Johnson	222,746	468,609	801,464	932,230	861,189	− 71,041
Knox	610,705	654,478	764,601	840,872	961,492	+ 120,620
Laurel	214,251	275,224	242,728	226,990	196,569	− 30,421
Lawrence	96,440	100,895	52,146	67,234	69,157	+ 1,923
Lee	84,109	67,693	45,857	47,744	30,152	− 17,592
Letcher	.....	.....	.....	193,298	1,105,452	+ 912,154
McCreary	.....	.....	.....	543,307	625,101	+ 81,794
Morgan	.....	70,061	75,581	89,958	90,346	+ 388
Pike	684,450	963,605	1,136,997	1,406,462	2,124,041	+ 717,579
Pulaski	61,723	85,218	69,437	1,000	1,500	+ 500
Rockcastle	.....	5,000	.....	190	.....	− 190
Whitley	933,154	1,167,937	1,182,308	999,965	1,015,370	+ 15,385
Other counties and small mines	190,663	45,255	86,773	64,153	86,034	+ 21,881
Total	4,826,099	6,279,024	6,889,162	8,617,193	11,098,960	+2,481,767

Coal production of the western district of Kentucky, 1909–1913, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Butler	7,228	1,756	1,580	.....	.....	.....
Christian	45,453	37,136	32,418	60,139	69,525	+ 9,386
Daviess	61,175	73,786	78,135	90,025	48,543	− 41,482
Hancock	15,110	6,364	650	3,800	6,280	+ 2,480
Henderson	163,782	241,281	223,957	236,159	220,582	− 15,577
Hopkins	1,864,453	2,554,620	2,156,021	2,549,113	2,534,821	− 14,292
McLean	128,015	206,001	122,382	122,331	83,329	− 39,002
Muhlenberg	2,009,549	2,738,427	2,243,193	2,368,037	2,633,271	+ 265,234
Ohio	626,158	819,397	769,885	661,386	775,545	+ 114,159
Union	444,457	590,378	462,683	550,421	690,968	+ 140,547
Webster	449,506	1,026,188	878,466	1,172,484	1,394,663	+ 222,179
Other counties and small mines	56,397	48,961	191,171	[a] 59,433	[a] 60,113	+ 680
Total	5,871,285	8,344,295	7,160,541	7,873,328	8,517,640	+ 644,312

[a] Small mines only.

In 1912, for the first time in the history of coal mining in the State, the eastern district had the larger production. The lead will be maintained and widened by the continued increase of production in the recently developed virgin areas already referred to.

So far as the records of early coal production in the United States are to be accepted, Kentucky was the third State to enter the list of regular coal producers. According to one of the early reports of the Kentucky Geological Survey (published in 1838), the first coal produced in the State was mined in 1827 on "the right side of the (Cumberland) river below the mouth of Laurel." This was evidently from either Laurel or Pulaski County, but the exact location is not definitely stated. The same report says that in 1828 five boatloads of coal from these mines arrived at Nashville, and that from 1829 to 1834 probably from 25 to 35 boatloads were sent out each year. The boatloads averaged about 1,750 bushels, or 66 tons

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each. From 1834 to 1837 the shipments were from 75 to 100 boatloads, or about 3,500 bushels annually. The coal was for the most part consumed in the salt works and iron furnaces convenient to the rivers, the only means of transportation.

From the best information obtainable it seems that the production of the State from 1829 to 1835 ranged from 2,000 to 6,000 tons a year. The United States census for 1840 gives the total production in the State as 23,527 short tons. By 1860, according to the census for that year, the production amounted to 285,760 short tons. Operations were necessarily somewhat interrupted during the Civil War, but since 1870, after the State had begun to recover from the effects of the war, the production increased rapidly, as shown in the following table, giving the annual and total production from 1828 to the close of 1913:

Production of coal in Kentucky from 1828 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1828	328	1850	150,000	1872	380,800	1894	3,111,192
1829	2,000	1851	160,000	1873	400,000	1895	3,357,770
1830	2,000	1852	175,000	1874	360,000	1896	3,333,478
1831	2,100	1853	180,000	1875	500,000	1897	3,602,097
1832	2,500	1854	190,000	1876	650,000	1898	3,887,906
1833	2,750	1855	200,000	1877	850,000	1899	4,607,255
1834	5,000	1856	215,000	1878	900,000	1900	5,328,964
1835	6,000	1857	240,000	1879	1,000,000	1901	5,469,986
1836	8,000	1858	250,000	1880	946,288	1902	6,766,984
1837	10,000	1859	275,000	1881	1,232,000	1903	7,538,032
1838	11,500	1860	285,760	1882	1,300,000	1904	7,576,482
1839	16,000	1861	280,000	1883	1,650,000	1905	8,432,523
1840	23,527	1862	275,000	1884	1,550,000	1906	9,653,647
1841	35,000	1863	250,000	1885	1,600,000	1907	10,753,124
1842	50,000	1864	250,000	1886	1,550,000	1908	10,246,553
1843	60,000	1865	200,000	1887	1,933,185	1909	10,697,384
1844	75,000	1866	180,000	1888	2,570,000	1910	14,623,319
1845	100,000	1867	175,000	1889	2,399,755	1911	14,049,703
1846	115,000	1868	160,000	1890	2,701,496	1912	16,490,521
1847	120,000	1869	160,000	1891	2,916,069	1913	19,616,600
1848	125,000	1870	150,582	1892	3,025,313		
1849	140,000	1871	250,000	1893	3,007,179	Total.	208,128,654

MARYLAND.

Total production in 1913, 4,779,839 short tons; spot value, $5,927,046.

The coal production of Maryland in 1913 was less than that of 1912 by 184,199 short tons, or 3.7 per cent, but the value showed a gain of $87,967, or 1.5 per cent, and exceeded that of any year since 1907. The annual production of coal in Maryland has been fairly constant for the last 16 years, the smallest production in that period being in 1909, when it amounted to 4,023,241 tons, and the largest production in 1907, when it reached as high as 5,532,628 tons. The output in 1913 was very close to the average of the 16 years. It is not to be expected that the production will show any material increase in the future, as the great bed, the "Maryland Big Vein," from which the greater part of the output has been obtained, is approaching exhaustion, and, although there is still a good supply remaining in the thinner and deeper beds, it is not at all probable that the future annual tonnage from them will exceed the records of the past, if indeed it maintains the same importance.

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Although by far the greater part (more than 90 per cent) of Maryland's coal production is mined by hand, the record of individual efficiency by the miners is high. In 1913 there were 5,645 men employed in the coal mines of the State, and they worked an average of 248 days, as compared with 6,162 men for an average of 259 days in 1912. The average production by each man in 1913 was 847 tons for the year and 3.42 tons for each working day. In 1912 the average production per man for the year was 806 tons and the average daily production per man was 3.11 tons. These are exceptionally good averages, especially when it is considered that in 1913 4,373,920 tons, or 91.5 per cent of the total, were mined by hand, and that in 1912 nearly 95 per cent of the total product was hand mined. The machine-mined product in 1913 was only 82,989 short tons, or 1.7 per cent of the total. The quantity of coal shot off the solid was 293,950 tons.

There was only one instance of labor trouble in 1913 and that was insignificant, 200 men being idle for 2 days. In 1912 there were but three strikes reported, the longest of which lasted 12 days.

The Bureau of Mines reported 13 fatal accidents in 1913 in the coal mines of Maryland, the same number as in 1912; but as there were fewer men employed and fewer tons mined in 1913 the ratio of deaths was slightly increased and the tonnage per life lost was slightly less. The death rate per thousand in 1913 was 2.3 against 2.11 in 1912, and the quantity of coal mined for each life lost was 367,680 tons against 381,849 tons. The records for both years were better than the average and were improved upon by only a few States.

The statistics of the production of coal in Maryland in 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

Coal production of Maryland in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Allegany	4,036,128	37,787	62,895	4,136,810	$5,129,153	$1.24	265	5,242
Garrett	800,263	6,811	3,245	810,319	690,566	.85	228	920
Small mines	.....	16,909	.....	16,909	19,360	1.14	.....	.....
Total	4,836,391	61,507	66,140	4,964,038	5,839,079	1.18	259	6,162

1913.

Allegany	3,943,759	32,605	61,897	4,038,261	$5,277,261	$1.31	246	4,771
Garrett	722,999	6,255	1,835	731,089	638,028	.87	261	874
Small mines	.....	10,489	.....	10,489	11,757	1.12	.....	.....
Total	4,666,758	49,349	63,732	4,779,839	5,927,046	1.24	248	5,645

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The statistics of production during the last five years, with the distribution of the product for consumption, are shown in the following table:

Distribution of the coal product of Maryland, 1909–1913, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1909	3,917,803	55,882	49,556	4,023,241	$4,471,731	$1.11	.....	8,004
1910	5,097,347	62,760	57,018	5,217,125	5,835,058	1.12	270	5,809
1911	4,547,660	72,050	66,145	4,685,795	5,197,066	1.11	248	5,881
1912	4,836,391	61,507	66,140	4,964,038	5,839,079	1.18	259	6,162
1913	4,666,758	49,349	63,732	4,779,839	5,927,046	1.24	248	5,645

Comparisons of the total production, by counties, in 1912 and 1913, are shown in the following table:

Coal production of Maryland, 1912 and 1913, by counties, in short tons.

County.	1912	1913	Increase(+) or decrease (−), 1913.
Allegany	4,136,810	4,038,261	− 98,549
Garrett	810,319	731,069	− 79,250
Small mines	16,909	10,489	− 6,420
Total	4,964,038	4,779,839	−184,199
Total value	$5,839,079	$5,927,046	+$87,967

The coal deposits of Maryland are confined to a limited area in the two western counties of the State, Allegany and Garrett. There are five basins known, respectively, as Georges Creek, Upper Potomac, Castleman, Lower Youghiogheny, and Upper Youghiogheny. Most of the production in the past has been in the Georges Creek basin, which, in Allegany County, contains a detached portion of the Pittsburgh bed known generally in this region as the "Maryland Big Vein." This bed has been worked for nearly a hundred years and is now approaching exhaustion. The greater prominence of the Georges Creek basin as the source of Maryland's coal production has given the name "Georges Creek" to most of the coal shipped from the State. Georges Creek coal has a high reputation as a steam and blacksmith fuel. It does not, however, possess strong coking qualities, and none of it is used for that purpose. The development of the upper Potomac basin in Garrett County began about 1895 and that area is now extensively worked. The other three basins are practically untouched. The gradual exhaustion of the "Big Vein" has led to the exploitation of some of the smaller beds in the Georges Creek basin, and many companies that formerly worked the "Big Vein" alone are now mining the thinner beds either independently or in conjunction with the big bed. The total amount of coal recoverable from the numerous small beds far exceeds the original contents of the "Big Vein," but they can not be so cheaply worked, and it appears

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doubtful if, in the annual production, they will do more than make up the deficiency caused by the exhaustion of the main bed.

Although coal was discovered in the Georges Creek basin as early as 1782, the first eastern shipments from the Maryland coal district were not made until 1830, when small quantities were transported by barges down the Potomac River. The first company was incorporated in 1836. After the construction of the Baltimore & Ohio Railroad, in 1842, and of the Chesapeake & Ohio Canal, in 1850, the output from the Maryland mines increased rapidly.

The attempt to ship coal from the Maryland mines by barges, prior to the advent of the Baltimore & Ohio Railroad, was not long continued. The method was too destructive of life and was the cause of so much loss in coal that it was soon abandoned, and it was not until 1842 that the industry really began to assume importance. The first shipments over the Chesapeake & Ohio Canal from Cumberland were made in 1850.

Maryland and the adjoining counties in West Virginia, which make up what is known as the Cumberland region, constitute the only districts outside of the anthracite region of Pennsylvania where records of coal production have been kept from the earliest years. These districts have been commonly known as the Georges Creek or Cumberland and the Piedmont regions. The Cumberland region was opened in 1842. The Piedmont region began shipping in 1853. The records of shipment have been carefully preserved and are published annually in the reports of the Cumberland coal trade.

The annual production from the coal mines of Maryland from 1820 to the close of 1913 has been as follows:

Production of coal in Maryland from 1820 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1820	3,000	1859	833,349	1878	2,068,925	1897	4,442,128
1832	12,000	1860	438,000	1879	2,132,233	1898	4,674,884
1840	8,880	1861	287,073	1880	2,228,917	1899	4,807,396
1842	2,104	1862	346,201	1881	2,533,348	1900	4,024,688
1843	12,421	1863	877,313	1882	1,555,445	1901	5,113,127
1844	18,345	1864	755,764	1883	2,476,075	1902	5,271,609
1845	30,372	1865	1,025,208	1884	2,765,617	1903	4,846,165
1846	36,707	1866	1,217,668	1885	2,833,337	1904	4,813,622
1847	65,222	1867	1,381,429	1886	2,517,577	1905	5,108,539
1848	98,032	1868	1,529,879	1887	3,278,023	1906	5,435,453
1849	175,497	1869	2,216,300	1888	3,479,470	1907	5,532,628
1850	242,517	1870	1,819,824	1889	2,939,715	1908	4,377,093
1851	317,460	1871	2,670,338	1890	3,357,813	1909	4,023,241
1852	411,707	1872	2,647,156	1891	3,820,239	1910	5,217,125
1853	657,862	1873	3,198,911	1892	3,419,962	1911	4,685,795
1854	812,727	1874	2,899,392	1893	3,716,041	1912	4,964,038
1855	735,137	1875	2,808,018	1894	3,501,428	1913	4,779,839
1856	817,659	1876	2,126,873	1895	3,915,585		
1857	654,017	1877	1,939,575	1896	4,143,936	Total	175,653,679
1858	722,686						

MICHIGAN.

Total production in 1913, 1,231,786 short tons; spot value, $2,455,227.

Michigan participated in the general increase in coal production in 1913, though the gain, both in quantity and value, was small, and the total was less than in any year from 1903 to 1911, inclusive. The

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increase as compared with 1912, when the production amounted to 1,206,230 short tons, valued at $2,399,451, was 25,556 tons, or 2.12 per cent in quantity, and $55,776, or 2.32 per cent in value. Michigan's coal production has exceeded 2,000,000 short tons in one year only, 1907, since when it decreased steadily until 1912, when it reached the minimum for the decade. The decrease is attributed to the competition of higher-grade coals from West Virginia and to the small demand for lump coal in the manufacturing plants of the State. Michigan is an important manufacturing State, particularly in furniture and in the evaporation of salt. The modern character of the State's manufacturing establishments is indicated by the fact that most of them are equipped with mechanical stokers, using slack coal obtained cheaply from West Virginia and of better quality than the Michigan product. Michigan slack thus becomes a drug on the market, and the coal mines are obliged to depend almost exclusively on the domestic trade which requires lump coal. In winter the demand for lump coal exceeds the capacity of the mines and in summer the production exceeds the demand.

The coal operators of the State keep pace with the manufacturing interests in modern methods and equipment, as is shown by the large number of machines installed for mining the coal and the large proportion of coal undercut by them. In 1913 862,700 short tons, or 70 per cent of the total, were machine mined. The total number of machines in use was 130, an increase of 4 over 1912. The 130 machines included 26 punchers, 38 chain-breast, and 66 short-wall or continuous cutters. Unfortunately the record for modern practice is somewhat marred by the quantity of coal shot off the solid, 363,856 tons, or 29.5 per cent of the total, being reported as "mined" in 1913 in this way. The quantity of coal sent to washeries in 1913 was 166,709 tons, which yielded 145,840 tons of cleaned coal and 20,869 tons of refuse.

In spite of the larger proportion of machine-mined coal in 1913 (that of 1912 being about 50 per cent) the tonnage per man was less in the later year. In 1912 3,113 men, working an average of 183 days, produced 1,206,230 tons, or an average of 387 tons per man for the year and of 2.11 tons per day. In 1913 3,305 men were employed for an average of 188 days and produced 1,231,786 tons, or an average for the year of 373 tons and for each day of 1.98 tons. The mines were practically free from labor troubles in 1913, one strike of 7 men for 180 days being the only exception reported.

The coal-mine fatalities as reported to the Bureau of Mines consisted of 2 deaths from falls of roof and 1 death from falling down a shaft, a total of 3, as compared with 8 in 1912 and 7 in 1911. The death rate in 1913 was a fraction less than 1, and there were 410,595 tons mined for each life lost.

The statistics of production of coal in Michigan, by counties, during 1912 and 1913, with the distribution of the product for consumption, are shown in the following tables:

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Coal production of Michigan in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bay	584,006	7,828	39,098	630,931	$1,237,449	$1.96	173	1,664
Saginaw	440,032	46,838	17,742	504,612	1,025,959	2.03	193	1,302
Other counties [a] and small mines	56,282	7,745	6,660	70,687	136,043	1.92	203	147
Total	1,080,319	62,411	63,500	1,206,230	2,399,451	1.99	183	3,113

1913.

Bay	558,170	5,513	28,035	591,718	$1,176,095	$1.99	202	1,465
Saginaw	524,079	44,874	27,240	596,193	1,194,553	2.00	176	1,750
Other counties [b] and small mines	29,741	7,864	6,270	43,875	84,579	1.93	208	90
Total	1,111,990	58,251	61,545	1,231,786	2,455,227	1.99	188	3,305

[a] Clinton, Ingham, and Tuscola. [b] Clinton, Ingham, Shiawassee, and Tuscola.

The statistics of production, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912, are shown in the following table:

Coal production of Michigan, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Bay	822,577	766,470	717,084	630,931	591,718	− 39,213
Eaton	558	100	1,000	.....	.....	.....
Jackson	1,500	.....	.....	.....	.....	.....
Saginaw	859,434	667,282	667,954	504,612	596,193	+ 91,581
Shiawassee	[a] 100,623	[b] 101,115	[b] 90,036	[b] 70,687	[a] 43,875	− 26,812
Total	1,784,692	1,534,967	1,476,074	1,206,230	1,231,786	+ 25,556
Total value	$3,199,351	$2,930,771	$2,791,461	$2,399,451	$2,455,227	+$55,776

[a] Includes Clinton, Ingham, and Tuscola counties and small mines.
[b] Includes Clinton, Genesee, Ingham, and Tuscola counties and small mines.

The coal fields of Michigan occupy an isolated basin in the Lower Peninsula. They have an area of approximately 11,000 square miles in almost the exact center of the Peninsula. The fields are estimated to have originally contained 12,000,000,000 tons of coal, from which the exhaustion to the close of 1913 has amounted to about 34,400,000 tons. It is only within the last 12 years that the coal fields of Michigan have been worked to any considerable extent, and their development has followed in some degree the depletion of the forest resources. The lumber industry of Michigan has materially declined. Formerly the refuse from the lumber mills furnished fuel not only for their own operations but for salt-evaporating plants which were operated as a by-industry of the lumber mills. The exhaustion of the forests and

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the decline of the lumber industry have created a demand for coal to supply the salt works and other manufacturing establishments of the State. The decline in the lumber industry in Michigan is exhibited by the statistics compiled by the Twelfth and Thirteenth Censuses in cooperation with the United States Forest Service. In 1900 the lumber cut amounted to 3,462,152,000 board feet. The State was second in rank of quantity of lumber cut. In 1905 the lumber cut of Michigan had declined to 2,006,670,000 board feet and the State to third in rank. In 1910 Michigan's lumber cut had fallen to 1,681,081,000 board feet and the State to ninth in rank.

The principal coal-mining operations are in Bay and Saginaw counties, with a smaller production (chiefly from local mines) in Clinton, Ingham, Shiawassee, and Tuscola counties.

Coal was known to exist in Michigan early in the last century, and some mining is said to have been done in the Jackson field as early as 1835. Other mines were opened at Grand Ledge, in Clinton County, in 1838. It is known that some coal was produced at that place in those early years, but there is no record of the output prior to the census report of 1860, in which year Michigan was credited with a production of 2,320 tons. It was only in the closing decade of the last century that serious attention began to be paid to the coal resources of the State, and prior to 1896 the production had exceeded 100,000 tons in four years only. In 1897 it exceeded 200,000 tons, in 1899 it exceeded 600,000 tons, and in the first year of the present century it reached a total exceeding 1,200,000 tons. The maximum output of 2,035,858 tons was reached in 1907.

The record, by years, from 1860 to 1913, inclusive, is shown in the following table:

Production of coal in Michigan, 1860 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1860	2,320	1874	58,000	1888	81,407	1902	964,718
1861	3,000	1875	62,500	1889	67,431	1903	1,367,619
1862	5,000	1876	66,000	1890	74,977	1904	1,342,840
1863	8,000	1877	69,197	1891	80,307	1905	1,473,211
1864	12,000	1878	85,322	1892	77,990	1906	1,346,338
1865	15,000	1879	82,015	1893	45,979	1907	2,035,858
1866	20,000	1880	100,800	1894	70,022	1908	1,835,019
1867	25,000	1881	112,000	1895	112,322	1909	1,784,692
1868	28,000	1882	135,339	1896	92,882	1910	1,534,967
1869	29,980	1883	71,296	1897	223,592	1911	1,476,074
1870	28,150	1884	36,712	1898	315,722	1912	1,206,230
1871	32,000	1885	45,178	1899	624,708	1913	1,231,786
1872	33,600	1886	60,434	1900	849,475		
1873	56,000	1887	71,461	1901	1,241,241	Total	22,911,711

MISSOURI.

Total production in 1913, 4,318,125 short tons; spot value, $7,468,308.

Compared with 1912, when the coal production of Missouri amounted to 4,339,856 short tons, valued at $7,633,864, the returns for 1913 show a decrease of 21,731 tons, or 0.5 per cent, in quantity and of $165,556, or 2.2 per cent, in value. With the exception of 1912, however, the output in 1913 was the largest in the history of

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the State. The decreased production in 1913 was due, primarily, to the exceptionally mild weather in February and March, the output in those two months being nearly 135,000 tons less than in the corresponding period in 1912. The deficiency was made up in part by an increased demand by the railroads, a portion of whose supply had been cut off by the unsettled conditions in Colorado, and also by an improved demand for household consumption during the fall months. The demand for steam coal by the manufacturing interests was well maintained during the year. The coal-mining industry suffered somewhat from the drought during the summer months, and at times water for boiler use had to be hauled to the mines. Transportation facilities were ample and satisfactory, and there was little interruption to mining operations on account of labor troubles. There were occasional shutdowns, but no prolonged periods of idleness, the total time lost being less than 2 per cent of the time made. All told, there were 918 men on strike during the year, and the average number of idle days was 34.

The proportionately larger decrease in the value of the product in 1913, shown by the decline from $1.76 to $1.73 in the average value of coal per ton, was due to the warm weather and the slackened demand in February and March, when, as a usual thing, better prices prevail than in the summer months.

Notwithstanding the decreased production in 1913, the number of men employed increased from 9,704 to 10,418, but there was a decrease in the average number of working days—from 206 in 1912 to 187 in 1913. The average annual production per man was 414 tons and 2.21 tons for each working day in 1913, as compared with 447 tons and 2.17 tons, respectively, in 1912. Mining machines are used chiefly in the thin beds where long-wall mining is practiced. In consequence, the long-wall type of machine is in the majority, 80 out of a total of 104 machines employed in 1913 being of that type. Of the other 24, 10 were short-wall and 7 each chain-breast and punchers. In 1912 there were 86 machines reported. In spite of the increased number of machines in 1913 the quantity of machine-mined coal decreased from 898,852 tons to 863,946 tons, the item constituting 20 per cent of the total output in 1913. About one-half of Missouri's coal production is "powder-mined," 2,021,292 short tons, or 47 per cent of the total, being shot off the solid in 1913, against 2,083,656 tons, or 48 per cent of the total, in 1912. The hand-mined coal reported in 1913 amounted to 1,018,588 tons. The method employed in mining about 400,000 tons was not reported.

The number of fatal accidents in the coal mines of Missouri in 1913 was reduced to just one-half of the fatalities of the preceding year, or from 20 to 10, according to reports to the Bureau of Mines, and the death rate per thousand was reduced to a fraction less than 1, as compared with 2.06 in 1912. Of the 10 fatalities in 1913, 8 were due to falls of roof. The quantity of coal mined for each life lost in 1913 was 431,813 tons, against 216,993 tons in 1912.

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The statistics of production, by counties, in 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

Coal production of Missouri in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adair	563,015	20,014	10,638	593,667	$965,880	$1.63	231	931
Audrain	6,356	16,752	2,404	25,512	56,683	2.22	234	103
Barton	361,606	8,689	11,787	382,082	598,399	1.57	194	619
Bates	140,303	14,805	4,121	159,229	277,225	1.74	190	282
Boone	.....	19,556	140	19,696	39,016	1.98	148	78
Callaway	11,900	11,052	10	22,962	56,504	2.46	233	83
Dade	200	5,320	80	6,100	11,825	1.94	146	12
Henry	107,160	33,549	2,875	143,584	260,396	1.81	161	428
Lafayette	683,283	47,358	18,957	749,598	1,454,965	1.94	227	2,018
Linn	100,450	22,174	3,025	125,649	287,504	2.29	219	410
Macon	779,358	23,687	15,125	818,170	1,251,755	1.53	179	1,629
Putnam	25,198	5,737	775	31,710	54,828	1.73	118	163
Randolph	448,450	27,297	8,156	483,903	781,919	1.62	239	1,089
Ray	340,793	28,339	6,032	375,164	723,981	1.93	191	1,182
Other counties [a]	240,260	48,407	15,348	304,015	607,601	2.00	206	727
Small mines	.....	98,815	.....	98,815	205,383	2.08	.....	.....
Total	3,808,332	432,051	99,473	4,339,856	7,633,864	1.76	206	9,704

1913.

Adair	407,358	21,475	11,158	439,991	$699,244	$1.59	139	1,031
Audrain	3,031	7,424	151	10,606	21,842	2.06	139	51
Barton	475,325	10,784	9,219	495,328	796,992	1.61	198	735
Bates	145,700	16,551	6,218	168,469	264,857	1.57	182	311
Boone	1,927	13,780	84	15,791	30,563	1.94	202	69
Callaway	739	31,860	300	32,899	69,907	2.13	185	166
Dade	120	5,630	.....	5,750	9,762	1.70	122	19
Henry	182,900	76,176	2,120	261,196	437,194	1.67	226	474
Lafayette	666,343	45,441	17,822	729,606	1,347,090	1.85	201	2,073
Linn	97,100	17,699	2,826	117,625	276,455	2.35	199	369
Macon	743,783	21,745	12,736	778,264	1,255,417	1.61	172	1,681
Putnam	17,433	3,852	500	21,835	45,409	2.08	108	119
Randolph	443,099	29,778	9,005	481,882	769,802	1.60	220	1,074
Ray	312,123	22,389	8,773	343,285	651,227	1.90	152	1,261
Other counties [b]	268,513	45,553	14,565	328,631	613,528	1.87	224	985
Small mines	.....	86,977	.....	86,977	179,019	2.06	.....	.....
Total	3,765,534	457,114	95,477	4,318,125	7,468,308	1.73	187	10,418

[a] Caldwell, Cass, Clay, Cole, Grundy, Harrison, Howard, Johnson, Livingston, Moniteau, Montgomery, Platte, Ralls, Schuyler, Sullivan, and Vernon.

[b] Caldwell, Clay, Cole, Cooper, Grundy, Harrison, Howard, Johnson, Moniteau, Montgomery, Platte, Ralls, Schuyler, Sullivan, and Vernon.

The statistics of production during the last five years, by counties, with increase and decrease in 1913 as compared with 1912, are shown in the following table:

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Coal production in Missouri, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Adair	576,485	408,007	348,559	593,667	439,991	— 153,676
Audrain	41,207	40,662	29,673	25,512	10,606	— 14,906
Barton	259,766	222,595	296,236	382,082	495,328	+ 113,246
Bates	147,322	95,451	88,620	159,229	168,469	+ 9,240
Boone	18,000	19,885	22,031	19,696	15,791	— 3,905
Caldwell	7,815	7,300	3,181	2,015	4,200	+ 2,185
Callaway	25,179	28,954	36,411	22,962	32,889	+ 9,927
Grundy	9,818	9,640	8,000	10,000	10,000	.....
Henry	268,352	145,644	240,571	143,584	261,196	+ 117,612
Johnson	8,128	2,532	1,500	3,411	3,690	+ 279
Lafayette	715,223	553,832	765,879	749,598	729,606	— 19,992
Linn	134,260	89,311	123,169	125,649	117,625	— 8,024
Livingston	400	200	.....	500	.....	— 500
Macon	790,088	613,949	675,933	818,170	778,264	— 39,906
Montgomery and Morgan	2,420	[a] 1,500	[a] 1,000	[a] 1,200	[a] 665	— 535
Putnam	48,120	61,968	30,276	31,710	21,835	— 9,875
Ralls	16,009	12,761	16,158	13,799	15,022	+ 1,223
Randolph	186,573	193,482	483,800	483,903	481,882	— 2,021
Ray	277,075	292,442	317,134	375,164	343,285	— 31,879
Vernon	20,278	7,208	2,658	2,340	10,073	+ 7,733
Other counties and small mines	209,017	175,110	346,318	375,665	377,708	+ 2,043
Total	3,756,530	2,982,433	3,836,107	4,339,856	4,318,125	— 21,731
Total value	$6,183,626	$5,328,285	$6,603,066	$7,633,864	$7,468,308	—$165,556

[a] Montgomery County only.

The coal fields of Missouri occupy the greater part of that portion of the State lying north and west of a line drawn from the northeast to the southwest corner. About 25,000 square miles contain coal-bearing formations of which about 60 per cent are potentially productive under present conditions and more will become available in the future. The supplies eventually recoverable are large and less than 1 per cent has been exhausted up to the present time. The coal is all of bituminous variety of medium quality, but is a fair steam producer. Developments have not kept pace with progress in some of the other States, largely because the markets that can be reached are restricted by the fuels, some of them of higher grade, from the States to the north, east, south, and west of Missouri. St. Louis secures its fuel from the more accessible fields of southwestern Illinois, and Kansas City depends to a large extent upon Arkansas, Kansas, and Oklahoma for coal. But a more potential factor in limiting the demand for Missouri coal in the last few years, or at least until 1912, has been the notable increase in the production of petroleum and natural gas in the Mid-Continent field of Kansas and Oklahoma. Natural gas from eastern Kansas is now piped to Kansas City, St. Joseph, and Joplin, Mo., and to Atchison, Leavenworth, and other cities in Kansas. Oil from the same district and from northern Oklahoma is being extensively used for fuel by manufacturers in Kansas City and other cities near the Missouri coal fields, and as long as these more desirable fuels are available the demand for Missouri coal is not likely to increase materially. Smaller supplies of gas and of fuel oil in 1912 and 1913 have caused an increase in the production of coal in the Southwestern States, an increase that was shared by Missouri. The interruptions to their regular supplies of fuel caused by the biyearly conflicts between coal operators and their miners has created a tendency on the part of manufacturers to substitute oil and

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gas for coal. The chief producing fields of the State are: (1) The Bevier, occupying parts of Macon, Randolph, Chariton, Howard, and Boone counties, and producing 27 per cent of the State's output from a bed that ranges from 3 to 6 feet in thickness. (2) The Lexington, including Lafayette, Ray, and Clay counties. The bed mined is only 14 to 26 inches thick and belongs in the Des Moines group. Because it is ideally adapted to the long-wall system of mining and is situated near large consuming centers, this bed, in spite of its thinness, produces 27 per cent of the total for the State. (3) The Southwestern, including various districts in Henry, Barton, Bates, and adjacent counties, where several beds are mined, chiefly in the lower part of the Des Moines group. About 20 per cent of the output comes from this part of the State. (4) The Novinger, in Adair County, which produces 15 per cent of the total output. The bed mined lies at the same stratigraphic horizon as the one in the Bevier field and averages 3½ feet in thickness. (5) The Marceline, in Linn County, where 4 per cent of the State's total production is taken from a bed 29 inches thick. (6) The Mendota, in Putnam, Schuyler, and northwestern Adair counties. The coal of this field lies stratigraphically about 100 feet above that in the Novinger field and probably at the same horizon as that of the Lexington field. It is the southern extension of the Mystic or Centerville bed of Iowa, but is not extensively mined in Missouri and produces only 2 per cent of the total for the State.

The occurrence of coal in Missouri appears to have been known as early as 1806, when, according to "An account of expeditions to the sources of the Mississippi," by Z. M. Pike, it was noted on the banks of Osage River. The coal attracted the attention of the early settlers, and numerous small local mines are reported to have been opened by them. No record is extant of the quantity of coal produced in those early days in Missouri, and the first statement regarding the quantity mined in the State is contained in the report of the United States Census for 1840, in which year a production of 9,972 tons is recorded. The annual output of coal in Missouri since 1840 is shown in the following table, the output from 1841 to 1869, inclusive, being estimates only:

Production of coal in Missouri from 1840 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	9,972	1859	260,000	1878	1,008,000	1897	2,665,626
1841	12,000	1860	280,000	1879	1,008,000	1898	2,688,321
1842	15,000	1861	300,000	1880	844,304	1899	3,025,814
1843	25,000	1862	320,000	1881	1,060,000	1900	3,540,103
1844	35,000	1863	360,000	1882	2,240,000	1901	3,802,088
1845	50,000	1864	375,000	1883	2,520,000	1902	3,890,154
1846	68,000	1865	420,000	1884	2,800,000	1903	4,238,586
1847	80,000	1866	450,000	1885	3,080,000	1904	4,168,308
1848	85,000	1867	500,000	1886	1,800,000	1905	3,983,378
1849	90,000	1868	541,000	1887	3,209,916	1906	3,758,008
1850	100,000	1869	550,000	1888	3,009,967	1907	3,997,936
1851	125,000	1870	621,930	1889	2,557,823	1908	3,317,315
1852	140,000	1871	725,000	1890	2,735,221	1909	3,756,530
1853	160,000	1872	784,000	1891	2,874,606	1910	2,982,433
1854	175,000	1873	784,000	1892	2,783,949	1911	3,836,107
1855	185,000	1874	789,680	1893	2,897,442	1912	4,339,856
1856	200,000	1875	840,000	1894	2,245,039	1913	4,318,125
1857	220,000	1876	1,008,000	1895	2,372,393		
1858	240,000	1877	1,008,000	1896	2,331,542	Total	120,168,472

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MONTANA.

Total production in 1913, 3,240,973 short tons; spot value, $5,653,539.

The influences which affected the coal-mining industry in Montana in 1913 were three in number—(1) an influx of settlers into the State, which resulted in an increased demand for domestic coal; (2) a decreased consumption by the railroads because of the increasing use of oil; and (3) extensive hydroelectric developments to supply light and power to many cities and to mining and manufacturing establishments. The use of hydroelectric power has even extended to some of the coal-mining plants themselves. The two latter influences have naturally resulted in a decreased demand for steam coal; but the larger demand for domestic coal more than outweighed the two adverse influences combined, and the production in 1913 showed an increase over 1912 of 192,478 short tons, or 6.3 per cent, in quantity and of $95,344, or 1.7 per cent, in value. The output in 1913 was the maximum attained, as had been the case in each of the four preceding years.

There were no serious interruptions to mining operations in 1913 because of labor troubles. The wage scale signed in 1912 was for two years, and consequently there was no controversy of a general character on that account. Operators claim, however, that notwithstanding increased wages and improved working conditions local disaffections have occurred, with short periods of idleness, and that leaders among the miners have had difficulty in making the rank and file live up to the spirit of the contracts into which they have entered. Altogether in 1913 there were six local strikes, which involved the idleness of 1,094 men for an average of six days each.

The curtailment of the steam-coal market, because of the reasons stated, has induced the larger operating companies to install cutting machines in order to reduce the quantity of small coal produced and to secure as great a percentage as possible of the larger coal required for the domestic trade. The installation of new coal-cutting machinery was particularly noticeable in the Bear Creek, Sand Coulee (Cottonwood), and Roundup fields. The total number of machines in use in the coal mines of Montana in 1913 was 97, as compared with 69 in 1912, and the quantity of machine-mined coal increased from 984,905 tons, or 32.3 per cent of the total product, in 1912 to 1,076,641 tons, or 33.2 per cent of the total, in 1913. The percentage of coal shot from the solid decreased from 37 (1,123,571 tons) in 1912 to 35 (1,143,364 tons) in 1913. The quantity of coal mined by hand in 1913 was 1,003,726 tons. Of the 97 machines in use, 53 were punchers, 22 chain-breast, 19 short-wall, and 3 radialaxe or post-punchers. The number of men employed in the coal mines of the State in 1913 was 3,630, and they worked an average of 228 days, against 3,440 men for an average of 220 days in 1912. The mine workers of Montana have a good efficiency record, and in 1912 the State showed the best average production per man per day among all the coal-producing States. In 1913 the average production per man for the year exceeded that of 1912 (893 tons against 886 tons), but the average daily output by each employee decrease from 4.03 tons to 3.92 tons.

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The fatality record maintained by the Bureau of Mines shows an unfortunate increase from the low point of 7 in 1912 to 20 in 1913, with an increase in the rate per thousand from 2.03 to 5.5, whereas the quantity of coal mined for each life lost decreased from 435,499 tons to 162,049 tons.

The statistics of production, by counties, during 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

Coal production of Montana in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Carbon	1,095,207	20,439	71,624	1,187,270	$2,472,534	$2.08	221	1,527
Cascade	794,766	16,419	44,391	855,576	1,340,392	1.57	210	1,054
Chouteau	7,638	13,352	600	21,590	53,924	2.50	292	41
Fergus	.....	6,251	.....	6,251	15,881	2.54	150	9
Hill	.....	9,674	325	9,999	16,352	1.64	242	19
Musselshell	878,452	7,745	27,707	913,904	1,532,629	1.68	232	656
Other counties [a]	42,440	5,365	3,293	51,098	119,572	2.34	203	134
Small mines	.....	2,807	.....	2,807	6,911	2.46	.....	.....
Total	2,818,503	82,052	147,940	3,048,495	5,558,195	1.82	220	3,440

1913.

Carbon	1,208,363	30,986	65,175	1,304,524	$2,660,952	$2.04	228	1,561
Cascade	863,516	35,132	13,986	912,634	1,351,142	1.48	209	1,094
Fergus	.....	5,348	.....	5,348	16,044	3.00	252	8
Hill	3,000	6,335	70	9,405	20,743	2.21	138	29
Musselshell	928,295	8,569	27,104	963,968	1,481,956	1.54	270	806
Other counties [b]	19,124	17,562	1,210	37,896	102,811	2.71	148	132
Small mines	.....	7,198	.....	7,198	19,891	2.76	.....	.....
Total	3,022,298	111,130	107,545	3,240,973	5,653,539	1.74	228	3,630

[a] Gallatin, Missoula, Park, Rosebud, and Valley.
[b] Blaine, Custer, Missoula, Park, Rosebud, and Valley.

In the following table is presented a statement of the coal production of Montana, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912:

Production of coal in Montana, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Carbon	989,664	1,211,028	1,185,189	1,187,270	1,304,524	+ 117,254
Cascade	954,657	928,306	994,043	855,576	912,634	+ 57,058
Chouteau	31,432	17,327	9,727	21,590	.....	− 21,590
Fergus	221,663	287,614	16,711	6,251	5,848	− 903
Gallatin	16,771	22,465	8,515	1,406	.....	− 1,406
Hill	.....	.....	.....	9,999	9,405	− 594
Musselshell	.....	.....	706,364	913,904	963,968	+ 50,064
Park	139,464	98,434	46,333	44,626	21,126	− 23,500
Other counties and small mines	200,289	355,796	9,476	7,873	23,968	+ 16,095
Total	2,553,940	2,920,970	2,976,358	3,048,495	3,240,973	+ 192,478
Total value	$5,036,942	$5,329,322	$5,342,168	$5,558,195	$5,653,539	+ $95,344

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The coal fields of Montana are widely scattered and range in the quality of their output from lignite to a fair grade of bituminous coal. Nearly all of the eastern third, or Great Plains, section of the State is underlain by lignite and low-grade subbituminous coal. As the mountainous district is approached the coals pass into high-grade subbituminous and true bituminous coals. These occur for the most part in relatively small and much scattered areas. In the valley region of the western part of the State the coals grade again into lignite, but, like those of the eastern part, they are also widely scattered and at present are not of economic importance. In point of production the most important field at the present time is what is known as the Red Lodge field, in Carbon County. Extensive mining operations are carried on in the vicinity of Red Lodge and Bear Creek, the production amounting to approximately 1,200,000 short tons annually. The coal is so nearly on the line between subbituminous and bituminous coal that classification is difficult. Second in importance, and the district that is now attracting the most attention, is the Bull Mountain field, in Musselshell County. It was opened in 1908, following the completion of the Chicago, Milwaukee & Puget Sound Railway, and from a production of less than 100,000 tons in that year has increased to over 960,000 tons in 1913. This coal is a good grade of subbituminous.

Until superseded in 1912 by the Bull Mountain field, the Great Falls field, in Cascade County, was second in point of production, and still is in its future potentiality as important as any, if not the most important, in the State. Mining is extensively carried on at Cottonwood, Stockett, and Belt, and, up to 1907, Cascade County was credited with more than half the production of the State. This coal is bituminous in grade, but somewhat dirty.

An extensive area of subbituminous coal underlies a large part of Chouteau County in the north-central part of the State, but the mining operations are comparatively small. Coal mining, principally for local consumption, is also carried on in Fergus, Gallatin, Hill, Missoula, Park, Rosebud, and Valley counties.

The first record of coal production in Montana was 32 years ago, in 1880, when the output amounted to only 224 tons. Up to 1888 the development had been rather slow, amounting to 41,467 tons in that year. In 1889 it rose to 363,301 tons and increased rapidly until 1895, when it reached a total of about 1,500,000 tons, and averaged approximately that quantity each year until 1904. Since 1904 it has shown an increasing tendency, reaching the maximum of 3,240,973 tons in 1913.

Production of coal in Montana from 1880 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1880	224	1889	363,301	1898	1,479,803	1907	2,016,857
1881	5,000	1890	517,477	1899	1,496,451	1908	1,920,190
1882	10,000	1891	541,861	1900	1,661,775	1909	2,553,940
1883	19,795	1892	564,648	1901	1,396,081	1910	2,920,970
1884	30,376	1893	802,309	1902	1,560,823	1911	2,976,358
1885	36,440	1894	927,395	1903	1,488,810	1912	3,048,495
1886	49,846	1895	1,504,193	1904	1,358,919	1913	3,240,973
1887	10,202	1896	1,543,445	1905	1,643,832		
1888	41,467	1897	1,647,882	1906	1,829,921	Total	41,400,659

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NEW MEXICO.

Total production in 1913, 3,708,806 short tons; spot value, $5,401,260.

In 1913, as in 1912, New Mexico outstripped all previous records in the production of coal. The output in 1912 was 3,536,824 short tons, valued at $5,037,051, compared with which that of 1913 showed an increase of 171,982 tons, or 4.86 per cent, in quantity and of $364,209, or 7.23 per cent, in value. As stated in previous reports, slight variations in values of New Mexico coal do not necessarily indicate any rise or fall in price, as in Colfax County, which produces 75 per cent of the total output of the State; the principal mining operations are carried on by companies affiliated with or subordinate to railroad and smelting interests, which consume the larger part of the product, and the fixing of values is simply a matter of accounting in which mining expense is an important factor. Colfax County in 1913 produced 2,749,765 short tons out of a total for the State of 3,708,806 tons. The average value per ton reported for Colfax County in 1913 was $1.33, against $1.31 in 1912 and $1.33 in 1911. More than one-third (938,432 tons) of the production of the county in 1913 was made into coke. Coke is not made in any other county in the State.

The number of men employed in the coal mines of New Mexico increased from 3,928 in 1912 to 4,329 in 1913, and the average number of working days increased from 274 to 289. The average production per man decreased from 900 tons for the year and 3.28 tons per day in 1912 to 857 tons and 2.97 tons, respectively, in 1913. This decreased tonnage per man was not due to any falling off in efficiency, but was one of the minor effects of an appalling disaster which occurred at mine No. 2 of the Stag Canon Fuel Co., at Dawson, in October, 1913. This accident, one of the most disastrous of the year in coal mining and the worst in the history of the State, caused the death of 261 persons. It occurred in one of the mines of a company which had spared no expense and had taken every precaution human intelligence could suggest to reduce the hazard of coal-mining operations. The other fatalities reported to the Bureau of Mines outside of the explosion at Dawson were 11, making a total of 272. The death rate per 1,000 for the year was 62.8, and the number of tons mined for each life lost was 13,635.

Most of the coal mined in New Mexico is undercut by hand, 2,548,243 tons, or 68.7 per cent of the total in 1913, being hand-mined. The quantity "powder-mined," or shot off the solid, was 652,969 tons, or 17.6 per cent of the total, and the machine-mined output was 497,070 tons, or 13.4 per cent. The number of machines in use increased from 25 in 1912, when 285,362 tons were produced by their use, to 44 in 1913. Short-wall, or continuous cutter, machines constituted 70 per cent of the total in 1913, 30 being of this type. Punchers numbered 7, chain-breast 6, and long-wall 1.

Only one instance of labor disaffection was reported in 1913, and in this 8 men were on strike for 130 days.

One company washes its slack coal used for coking, and in 1913, 587,853 tons of slack were washed, yielding 487,473 tons of cleaned coal and 100,380 tons of refuse.

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The statistics of production, by counties, during 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

Coal production of New Mexico in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Colfax	1,816,057	13,230	22,755	839,264	2,691,306	$3,514,360	$1.31	280	2,692
McKinley	709,015	6,662	19,867	.....	735,544	1,213,590	1.65	263	1,013
Other counties [a]	95,860	4,471	8,706	.....	109,037	307,032	2.82	246	223
Small mines	.....	937	.....	.....	937	2,069	2.21	.....	.....
Total	2,620,932	25,300	51,328	839,264	3,536,824	5,037,051	1.42	274	3,928

1913.

Colfax	1,774,776	12,345	24,212	938,432	2,749,765	$3,652,245	$1.33	288	3,200
McKinley	795,375	6,867	22,520	.....	824,762	1,367,364	1.66	293	862
Other counties [b]	115,729	5,299	10,251	.....	131,279	374,318	2.85	283	267
Small mines	.....	3,000	.....	.....	3,000	7,333	2.44	.....	.....
Total	2,685,880	27,511	56,983	938,432	3,708,806	5,401,260	1.46	289	4,329

[a] Lincoln, San Juan, Santa Fe, and Socorro.
[b] Bernalillo, Lincoln, Rio Arriba, San Juan, Santa Fe, and Socorro.

In the following table are presented the statistics of production, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912:

Coal production of New Mexico, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Colfax	2,013,318	2,651,585	2,297,611	2,691,306	2,749,765	+ 58,459
Lincoln	1,466	2,476	1,658	435	124	− 311
McKinley	665,423	696,730	731,365	735,544	824,762	+ 89,218
Rio Arriba	12,266	10,200	2,625	.....	7,500	+ 7,500
Santa Fe	46,495	73,106	58,726	57,239	67,852	+ 10,613
Other counties and small mines	62,160	72,224	56,173	52,300	58,803	+ 6,503
Total	2,801,128	3,508,321	3,148,158	3,536,824	3,708,806	+ 171,982
Total value	$3,619,744	$4,877,151	$4,525,925	$5,037,051	$5,401,260	+$364,209

As in Montana, the coal-bearing areas of New Mexico are in somewhat widely separated localities, as follows: (1) The Raton field of Colfax County, which is the southern extension of the Trinidad field of Colorado; (2) the San Juan River region, which extends from Durango, Colo., southward through Rio Arriba, San Juan, and McKinley counties to Gallup and Mount Taylor, and which embraces the producing districts of Gallup and Monero; (3) a large area farther south and east than the one noted above in Valencia, Bernalillo, and Sandoval counties, of which very little is known; (4) the Los Cerrillos field in Santa Fe County, including the little known areas

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east, south, and west of the Ortiz Mountains; and (5) the White Oaks field in Lincoln County. There are several other areas of little economic importance.

From the standpoint of production the most important field at the present time is the Raton field of Colfax County, about 75 per cent of the production being from this region. The product is a true coking coal and most of the operations are on an extensive scale. In 1913 there were 12 mines that produced over 100,000 tons. Over 900,000 tons, chiefly washed slack, were made into coke. There are five known coal beds of workable thickness, but most of the mining operations are on the lowest bed of the series.

In point of area the San Juan River field in the northwestern part of the State is the most important. It has in New Mexico an area of about 13,000 square miles, and like the Raton field crosses the northern boundary into Colorado. In the southern part of this field the coal is subbituminous in quality but grades into bituminous coal at the north in Colorado and at the northeast in New Mexico. The principal mining operations in the San Juan River field are in McKinley (formerly a part of Bernalillo) County. Three mines in this county produce over 100,000 tons each, and one of them over 200,000 tons.

The Los Cerrillos field in Santa Fe County and the White Oaks field in Lincoln County are relatively small in area, but contain true bituminous coal. In the former some of the coal has been locally altered into anthracite, of which 34,345 tons were mined in 1913. Operations in Lincoln County are small and the production is limited to local consumption. Mining on a small scale is also carried on in Socorro County from an isolated area containing bituminous coking coal.

The first record of coal production in New Mexico is that contained in the first volume of Mineral Resources of the United States, published in 1882. In that year the production amounted to 157,092 tons, about 4 per cent of what it is at the present time. The maximum was reached in 1913, when the production of coal in New Mexico was 3,708,806 short tons.

Production of coal in New Mexico from 1882 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1882.....	157,092	1891.....	462,328	1900.....	1,299,299	1909.....	2,801,128
1883.....	211,347	1892.....	661,330	1901.....	1,086,546	1910.....	3,506,321
1884.....	220,557	1893.....	665,094	1902.....	1,048,763	1911.....	3,143,158
1885.....	306,202	1894.....	597,196	1903.....	1,541,781	1912.....	3,536,824
1886.....	271,285	1895.....	720,554	1904.....	1,452,325	1913.....	3,708,806
1887.....	508,034	1896.....	622,626	1905.....	1,649,933		
1888.....	626,665	1897.....	716,981	1906.....	1,964,713	Total..	41,496,606
1889.....	486,943	1898.....	992,288	1907.....	2,628,959		
1890.....	375,777	1899.....	1,050,714	1908.....	2,467,937		

NORTH DAKOTA.

Total production in 1913, 495,320 short tons; spot value, $750,652.

All of the present mineral-fuel production of North Dakota is brown coal, or lignite. Considerable areas of subbituminous coal of usable quality and workable thickness are believed to underlie portions of the lignite areas, but no attempt to exploit the sub-

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bituminous coals has been made. The output of lignite in North Dakota decreased from 499,480 short tons, valued at $765,105, in 1912 to 495,320 tons, valued at $750,652, in 1913. Compared with 1911, when the production attained its maximum record (502,628 short tons), the output in 1913 shows a decrease of 7,308 tons. The relatively small differences in production during the last three years indicate an absence of any fluctuating influences and that active development of lignite properties will wait upon increased population. At present the consumption of lignite is chiefly for domestic purposes, but when properly handled and with proper equipment it can be used with satisfaction as a boiler fuel. A convincing example of what may be accomplished with lignite for such use is presented by the irrigation plant of the United States Reclamation Service at Williston. The lignite used is from the only coal mine owned and operated by the Government. The Reclamation Service operates the mine and uses the product in the generation of steam for its pumping plant connected with the irrigation project at Williston. The water is raised from Missouri River and delivered to an extensive system of canals and ditches by which a large section of the Missouri River Valley is irrigated. The mine of the Reclamation Service is located about 3 miles north of Williston and about a quarter of a mile from the power plant. It consists of a series of drifts in a 9-foot flat vein. The galleries or underground workings are at an average depth of about 100 feet below the surface. The main entry is about 2,000 feet in length, 6 feet wide and 6 feet high. The rooms are 100 to 150 feet long, 16 feet wide, and 8 feet high, with pillars between rooms 14 feet in width. Ventilation was at first obtained by the double-entry system, but on account of the increasing expense, due to the length of workings, artificial ventilation is to be resorted to with the aid of motor-driven fans and ventilating shafts at intervals. The mine is wet, the coal containing about 40 per cent of moisture, and drainage is effected by sumps from which the water is carried out in barrels. On account of vertical seams in the overlying soapstone rock, timbering is resorted to, the timber used being round tamarack or spruce. The main entry is permanently timbered and the headings are temporarily timbered. Because of a fungus growth all timbers are treated with a preservative.

The system of double entry mining is in use and the rooms, 16 feet in width, are widened on the return to 20 or 24 feet, by robbing the 14-foot pillars, after which the timbers are pulled and the mine is permitted to cave in. The average output at present is 100 tons a day. Coal is transported to the crusher near the power plant on cars hauled by mules and is there broken to nut size. The mine employs from 12 to 15 miners during the irrigation season of about five months in each year. The average output is from 6 to 10 tons of lignite per miner per day, and the net average earnings of the miners are from $3.50 to $5 a day of eight hours. The miners are furnished with permissible explosives at a slight advance above cost. Sleeping quarters are furnished free and meals can be obtained at 25 cents each. A bathroom, with individual lockers, gives the men an opportunity to use hot and cold shower baths. During the six months the mine was in operation in 1913 no fatal accidents were recorded, and only two or three serious ones. The average cost for

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producing lignite at the Reclamation Service mine was $1.56 per ton in 1911, $1.89 in 1912, and $1.44 in 1913. The value of the product in 1913 has been estimated at $1.60 per ton, as this was the average value of the commercial lignite produced in the county.[1]

At Kenmare, Scranton, and Dickinson lignite is successfully used in the burning of brick, for which purpose its smokeless and sootless qualities and relatively low cost make it adaptable. As the gas-producer and internal-combustion engines in large units come into more general use in the West, as they are rapidly doing in the East, the lignites of North Dakota will be found to possess great potentialities in the settlement and economic development of the State.

In Survey Bulletin 531 Frank A. Herald discusses the possibilities of using North Dakota lignite in the manufacture of briquets, as follows:[2]

> Some briquetting tests have been made with North Dakota lignite and have proved that the fuel can be treated successfully in that way. Tests at the Pittsburgh laboratory of the Bureau of Mines indicate that lignite from the Williston field can be economically briquetted.[3] Lignite from this field has been briquetted successfully at the North Dakota Mining and Experiment Station at Hebron, N. Dak.[4] The Pittsburgh tests were made with high pressure without binder, whereas the others were made with lower pressure and binder. As both methods gave favorable results, experimenters believe that the lignite can be successfully briquetted on a commercial basis both with and without binders. When briquetted the lignite can compete with higher-grade coal, as the briquets withstand weathering and do not crumble badly when handled. The process of briquetting removes 75 per cent of the water in the lignite, thus decreasing the weight about 30 per cent, and considerably increasing the heating value, by saving the heat otherwise needed to remove the moisture. Excessive moisture not only wastes heat during combustion but is also an important factor in freight charges, approximately one-third of the weight of most lignites being water. Briquetting, therefore, is especially useful because it increases the heat value and decreases the cost of transportation. In the tests mentioned above the heat value of the briquets made without binder was about 50 per cent greater than that of the raw material, and the briquets made at the Hebron experimental substation by a different process involving more thorough drying and the addition of binders showed a heat value about 70 per cent greater than the raw lignite.

The utilization of lignite, unless briquettes, to be successfully accomplished must be in the vicinity of the mines from which it is taken. When freshly mined North Dakota lignite contains about 40 per cent of moisture. Upon exposure to the atmosphere it gives up a large part of the moisture and then "slacks," or crumbles. Prolonged exposure reduces it to a rather fine powder with probably considerable oxidation and loss of volatile combustible material.

The lignite mines of North Dakota gave employment in 1913 to 641 men, who worked an average of 221 days, as compared with 622 men for an average of 232 days in 1912. The average production per man was 773 tons for the year and 2.9 tons each working day in 1913, against 803 and 3.5 tons, respectively, in 1912. The mines were entirely free from strikes, suspensions, or lockouts in 1913. Thirteen mining machines, 4 chain-breast, and 9 short-wall, were reported in use in 1913, and the quantity mined by machine was 222,227 short tons, or 44.9 per cent of the total. The quantity of lignite shot off the solid was 130,341 tons, or 26.3 per cent of the total.

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[1] Reclamation Record, pp. 9–10, January, 1914, and p. 58, February, 1914.
[2] Herald, F. A., The Williston lignite field, Williams County, N. Dak.: U. S. Geol. Survey Bull., pp. 104–105, 1913.
[3] Wright, C. L., Briquetting tests of lignite at Pittsburgh, Pa., 1908–9: Bureau of Mines Bull. 14, 1911.
[4] Babcock, E. J., Investigations of lignite coal relative to the production of gas and briquets: North Dakota School of Mines and Exper. Sta. Rept., 1911.

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The statistics of production, by counties, in 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

Coal production of North Dakota in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Adams	3,390	6,150	28	9,568	$11,630	$1.22	212	12
Burke	5,500	6,350	100	11,950	15,482	1.30	168	29
Burleigh	169,302	9,812	7,894	187,008	286,177	1.53	261	165
Hettinger	.....	11,005	24	11,029	12,921	1.17	265	16
Morton	18,190	17,806	330	36,326	51,276	1.41	186	45
Stark	55,308	2,800	1,677	59,785	78,546	1.31	240	55
Ward	63,380	25,384	510	89,274	160,995	1.80	211	190
Williams	12,495	9,527	931	22,953	35,821	1.56	227	37
Other counties [a]	27,330	13,691	140	41,161	65,859	1.60	263	73
Small mines	.....	30,426	.....	30,426	46,398	1.52	.....	.....
Total	354,895	132,951	11,634	499,480	765,105	1.53	232	622

1913.

Adams	4,707	4,822	55	9,584	$13,368	$1.39	201	17
Burke	5,139	6,861	175	12,175	14,885	1.22	190	20
Burleigh	176,208	9,475	8,319	194,002	283,918	1.46	202	234
Hettinger	.....	7,550	.....	7,550	8,435	1.12	177	7
McLean	676	7,827	213	8,716	12,601	1.45	250	6
Morton	19,605	20,076	805	40,486	57,232	1.41	222	53
Stark	50,632	3,475	1,450	55,557	79,380	1.43	208	52
Ward	53,270	19,426	4,414	77,110	137,245	1.78	256	154
Williams	2,595	24,602	561	27,758	44,474	1.60	196	50
Other counties [b]	37,000	8,015	....	45,015	72,365	1.61	262	48
Small mines	.....	17,367	.....	17,367	26,749	1.54	.....	.....
Total	349,832	129,496	15,992	495,320	750,652	1.52	221	641

[a] Bowman, Divide, Dunn, McLean, Mercer, and Oliver.
[b] Bowman, Divide, Mercer, and Oliver.

The statistics of production, by counties, during the last five years, with increase and decrease in 1913, as compared with 1912, are shown in the following table:

Coal production of North Dakota, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Burke	.....	.....	16,585	11,950	12,175	+ 225
Burleigh	122,422	142,597	173,214	187,008	194,002	+ 6,994
McLean	9,325	4,090	7,163	4,145	8,716	+ 4,571
Morton	18,634	23,250	20,034	36,326	40,486	+ 4,160
Stark	72,550	56,700	58,377	59,785	55,557	− 4,228
Ward	139,996	117,382	138,105	89,274	77,110	− 12,164
Williams	18,722	17,380	20,916	22,953	27,758	+ 4,805
Other counties and small mines	40,398	37,642	68,284	88,039	79,516	− 8,523
Total	422,047	399,041	502,628	499,480	495,320	− 4,160
Total value	$645,142	$595,139	$720,499	$765,105	$750,652	−$14,453

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The lignite areas of North Dakota occupy nearly all of the western half of the State and are estimated to contain about 35,000 square miles. According to the reports of the North Dakota Geological Survey, there are 97 townships which contain at least one bed of lignite 7 feet or more in thickness, in some places as much as 30 feet. At least 100 other townships contain beds from 4 to 7 feet in thickness. The lignite is well exposed along Missouri, Little Missouri, Knife, Heart, and Mouse rivers. Mining is carried on to some extent along the Northern Pacific Railway west of Mandan; on the Milwaukee, St. Paul & Sault Ste. Marie Railway in the Mouse River Valley and north of Bismarck; to less extent along the Great Northern Railway in the northwestern part of the State; and along the Chicago, Milwaukee & St. Paul Railway in the southwestern part. The principal mining operations are in the vicinity of Wilton, in Burleigh County, where the proximity to Bismarck and the markets provided by the State institutions, compelled by law to use North Dakota lignite for fuel, have encouraged development.

Lignite has doubtless been mined and used in North Dakota by ranchmen and others since the time when the State was a Territory, but it was not until 1884 that any record of production was obtained. This was published in the volume of Mineral Resources of the United States covering that year. The production since 1884 is given in the following table:

Production of coal in North Dakota from 1884 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1884.....	35,000	1892.....	40,725	1900.....	129,883	1908.....	320,742
1885.....	25,000	1893.....	49,630	1901.....	166,601	1909.....	422,047
1886.....	25,955	1894.....	42,015	1902.....	226,511	1910.....	399,041
1887.....	21,470	1895.....	38,997	1903.....	278,645	1911.....	502,628
1888.....	34,000	1896.....	78,050	1904.....	271,928	1912.....	499,480
1889.....	28,907	1897.....	77,246	1905.....	317,542	1913.....	495,320
1890.....	30,000	1898.....	83,895	1906.....	305,689		
1891.....	30,000	1899.....	98,809	1907.....	347,760	Total..	5,423,516

OHIO.

Total production in 1913, 36,200,527 short tons; spot value, $39,948,058.

All previous records in the coal production of Ohio were exceeded in 1913 both in quantity and in value, notwithstanding that coal-mining operations, like all other industries of the State, were seriously interfered with by an unprecedented inundation in the spring of the year. Mines were flooded and the transportation companies were practically out of business throughout a good part of the State for more than a month, so that the possible production was cut down probably 5,000,000 tons. In spite of this interruption the production increased from the previous maximum output of 34,528,727 short tons in 1912 to 36,200,527 tons in 1913, a gain of 1,671,800 tons, or 4.84 per cent. The value showed an increase of $2,864,695, or 7.73 per cent, from $37,083,363 to $39,948,058, and the average value per ton showed an advance of 3 cents, from $1.07 in 1912 to $1.10 in 1913. In spite of the interruption by the floods and the losses necessarily incident thereto, the year 1913 was one of the most satisfactory the coal operators of Ohio have experienced in

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recent history. Railroad consumption was larger than usual, and the demand from iron and steel furnaces and other manufacturing enterprises was good, except during the last quarter of the year. As if to equalize the excess of rainfall in the spring, there was during September, October, and November a deficiency in the water supply, drought conditions existing during a great part of that period, at which time also there was a shortage in transportation facilities due probably to the demands for crop movement. Some complaint was also made of shortage of labor and of the exacting character of its demands, with particular reference to the agitation for legislation requiring a mine-run basis of payment, instead of a screened-coal basis. The mine-run law was passed at the winter session of the legislature and has since been held constitutional by the courts.

Although the spring floods caused many of the mines to remain idle for a month or more, the average number of working days made by the employees and the average tonnage by each employee, both for the year and for each working day, were above the normal. The gain in total production was nearly 5 per cent, but there was an increase of only six-tenths of 1 per cent in the number of employees, from 45,527 in 1912 to 45,815 in 1913, which probably accounts for the complaints of labor shortage. The average working time was 206 days in 1913 against 201 days in 1912. The average production by each man employed was 790 tons for the year and 3.83 tons for each working day in 1913, against 758 tons and 3.77 tons, respectively, in 1912. The gains in individual production were due in large part to the larger production of machine-mined coal, in the proportion of which to the total tonnage Ohio stands well at the head among the coal-producing States. In 1913, 32,642,848 tons, or 90.2 per cent of Ohio's total production, were mined by machines. The increase in machine-mined coal was 2,594,017 tons, or 922,217 tons more than the total increase. At the present time Ohio enjoys the excellent record of having less than 4 per cent of the total output reported as shot off the solid or powder-mined. It will be interesting to note how this good record is maintained if the mine-run payment system is put into effect. A little over 4 per cent of the total production (1,600,605 tons) in 1913 was mined by hand. Electrically driven chain-breast machines far outnumber all other types of machines in the Ohio mines, as out of a total of 1,681 machines in use in 1913, 1,421, or nearly 85 per cent, were chain-breast. Short-wall machines are growing in popularity, as indicated by an increase in their number from 106 in 1912 to 187 in 1913. The number of long-wall machines increased from 2 to 17, and the number of pick machines decreased from 77 to 56.

Comparatively little of the coal product of Ohio is washed. In 1913 that item amounted to 306,713 tons, and yielded 269,178 tons of cleaned coal and 37,535 tons of refuse.

The total time lost by strikes and suspensions in 1913 was 263,234 days, 10,029 men being affected and their average time lost being 26 days. Distributed among the total number of employees, the average time lost was a fraction over 5 days, or about 3 per cent of the average time made.

Reports to the Bureau of Mines show that the coal-mining fatalities in 1913 numbered 165, of which 159 were underground, 4 in shafts, and 2 on the surface. The principal causes were falls of

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roof and coal, 93, or 56 per cent of the total; haulage accidents, 32; gas explosions, 15; and electricity, 9. The death rate per thousand was 3.6 and the number of tons mined for each life lost was 219,397. In 1912 there were 133 fatal accidents, and the rate per thousand was 2.9.

The statistics of production by counties, in 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

Coal production of Ohio in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Athens	4,660,471	32,183	117,920	9,200	4,819,774	$5,279,234	$1.10	186	6,711
Belmont	8,844,252	444,171	93,907	.....	9,382,330	9,063,554	.97	222	10,253
Carroll	272,377	44,675	5,917	.....	322,969	364,922	1.13	208	495
Columbiana	406,706	34,343	7,729	.....	448,778	538,314	1.20	163	854
Coshocton	315,635	52,277	3,487	.....	371,399	462,454	1.25	198	634
Guernsey	4,140,058	30,412	76,485	.....	4,246,955	4,153,222	.98	208	5,029
Harrison	773,130	28,223	11,600	.....	812,953	801,111	.99	248	871
Hocking	1,688,889	34,409	39,879	.....	1,763,177	2,003,839	1.14	207	2,600
Holmes	530	9,599	128	.....	10,257	13,523	1.32	158	33
Jackson	560,763	145,868	30,653	.....	737,284	1,236,512	1.68	153	1,843
Jefferson	4,341,988	430,658	84,918	665	4,858,529	5,016,305	1.03	216	5,772
Lawrence	24,890	41,568	.....	.....	66,158	74,610	1.13	131	243
Mahoning	18,270	14,482	442	.....	33,194	55,144	1.66	144	149
Medina	.....	6,457	222	.....	6,679	12,013	1.71	186	18
Meigs	597,920	37,225	9,318	.....	644,463	787,322	1.22	181	1,161
Muskingum	395,210	68,830	1,589	.....	465,629	498,643	1.07	198	656
Noble	615,253	6,309	2,942	.....	624,404	585,631	.94	211	635
Perry	2,052,737	45,317	47,862	.....	2,145,916	2,402,799	1.12	177	3,341
Stark	267,547	130,014	16,891	.....	414,452	722,457	1.74	190	836
Summit	69,685	4,391	5,386	.....	79,462	145,152	1.83	185	153
Tuscarawas	1,058,072	238,123	28,399	.....	1,324,594	1,516,645	1.14	213	1,863
Vinton	76,626	17,455	3,957	.....	97,938	111,852	1.14	135	277
Wayne	165,294	14,737	14,005	.....	194,036	372,202	1.92	133	429
Other counties [a]	364,625	9,243	6,930	.....	380,798	520,509	1.37	183	671
Small mines	.....	276,599	.....	.....	276,599	345,394	1.25	.....	.....
Total	31,710,928	2,197,368	610,566	9,865	34,528,727	37,083,363	1.07	201	45,527

1913.

Athens	4,901,707	37,559	125,067	4,300	4,968,633	$5,538,778	$1.11	186	7,143
Belmont	9,893,361	413,596	129,302	.....	10,436,259	10,745,972	1.03	222	10,946
Carroll	329,160	44,404	5,500	.....	379,064	424,546	1.12	217	623
Columbiana	471,425	34,467	16,912	.....	522,804	632,682	1.21	226	747
Coshocton	292,782	63,114	8,515	.....	364,411	473,401	1.30	247	621
Guernsey	4,215,033	44,497	62,462	.....	4,321,992	4,405,009	1.02	202	4,749
Harrison	701,310	16,659	12,252	.....	730,221	751,452	1.03	225	778
Hocking	1,605,021	35,308	38,294	.....	1,678,623	1,914,339	1.14	205	2,218
Holmes	500	8,472	15	.....	8,987	12,607	1.40	181	18
Jackson	473,187	94,386	19,471	.....	587,044	935,420	1.59	135	1,718
Jefferson	4,739,434	352,454	86,373	461	5,178,922	5,693,434	1.10	232	5,763
Lawrence	129,290	45,024	1,194	.....	176,098	216,058	1.23	200	388
Mahoning	4,875	10,771	140	.....	15,786	29,678	1.88	154	72
Meigs	596,457	38,453	8,815	.....	642,725	771,868	1.20	192	1,208
Muskingum	417,074	53,648	2,126	.....	472,748	515,986	1.09	226	653
Noble	767,367	9,734	10,240	.....	787,141	822,108	1.04	210	778
Perry	2,068,207	52,839	56,518	.....	2,177,564	2,412,031	1.11	188	3,235
Stark	252,532	143,040	21,666	.....	417,238	760,036	1.82	187	939
Tuscarawas	1,177,211	209,580	33,131	.....	1,419,922	1,603,968	1.13	230	1,853
Vinton	96,946	22,597	2,949	.....	122,492	140,771	1.15	171	248
Wayne	68,580	14,467	14,186	.....	97,233	203,811	2.10	126	273
Other counties [b]	424,647	13,111	19,160	.....	456,918	639,057	1.40	188	844
Small mines	.....	237,702	.....	.....	237,702	305,046	1.28	.....	.....
Total	33,525,096	1,996,382	674,288	4,761	36,200,527	39,948,058	1.10	206	45,815

[a] Gallia, Morgan, Portage, Scioto, and Trumbull.
[b] Gallia, Medina, Morgan, Portage, Scioto, Summit, and Trumbull.

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Of the 28 counties included in the table, 16 showed increased and 12 decreased output in 1913. Sixty per cent of the total increase was made in Belmont County, which exhibited a gain of 1,053,929 tons, or a little more than 10 per cent over 1912. Jefferson County came second with an increase of 320,393 tons; and the combined production of Noble and Scioto counties showed an increase of 160,650 tons. Athens County gained 148,859 tons, and Lawrence 109,940 tons. The largest loss was in Jackson County, 150,240 tons. Increases and decreases in other counties were less than 100,000 tons.

The statistics of production, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912, are shown in the following table:

Coal production of Ohio, 1909–1913, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Athens	4,131,270	5,593,560	4,292,527	4,819,774	4,968,633	+ 148,859
Belmont	6,061,573	8,265,019	8,092,127	9,382,330	10,436,259	+ 1,053,929
Carroll	390,273	313,517	269,167	322,969	379,064	+ 56,095
Columbiana	657,285	715,252	660,196	448,778	522,804	+ 74,026
Coshocton	373,981	427,341	390,812	371,399	364,411	− 6,988
Gallia	7,700	9,187	10,805	91,575	11,810	− 79,765
Guernsey	3,085,377	4,686,994	3,895,682	4,246,955	4,321,992	+ 75,037
Harrison	576,963	560,937	559,267	812,953	730,221	− 82,732
Hocking	1,194,895	1,635,575	1,576,119	1,763,177	1,678,623	− 84,554
Holmes	12,886	10,157	10,930	10,257	8,987	− 1,270
Jackson	784,463	878,656	669,591	737,284	587,044	− 150,240
Jefferson	3,908,118	5,241,681	4,687,731	4,858,529	5,178,922	+ 320,393
Lawrence	184,940	148,568	59,192	66,158	176,098	+ 109,940
Mahoning	40,904	60,434	52,748	33,194	15,786	− 17,408
Medina	13,017	24,148	14,187	6,679	5,445	− 1,234
Meigs	564,904	599,492	516,845	644,463	642,725	− 1,738
Morgan	191,391	124,336	174,513	193,745	279,481	+ 85,736
Muskingum	487,179	238,795	376,446	465,629	472,748	+ 7,119
Perry	2,133,266	2,283,257	2,086,799	2,145,916	2,177,564	+ 31,648
Portage	100,497	101,826	109,727	84,903	91,940	+ 7,037
Stark	496,272	496,509	450,256	414,452	417,238	+ 2,786
Summit	84,572	101,243	85,579	79,462	59,859	− 19,603
Trumbull	620	700	.....	1,035	930	− 105
Tuscarawas	1,577,303	816,189	677,330	1,324,594	1,419,922	+ 95,328
Vinton	151,954	86,801	104,338	97,938	122,492	+ 24,554
Wayne	101,050	159,138	209,059	194,036	97,233	− 96,803
Noble, Scioto	381,327	438,398	477,294	633,944	794,594	+ 160,650
Small mines	255,361	191,958	250,719	276,599	237,702	− 38,897
Total	27,939,641	34,209,668	30,759,986	34,528,727	36,200,527	+ 1,671,800
Total value	$27,789,010	$35,932,288	$31,810,123	$37,083,363	$39,948,058	+$2,864,695

The coal fields of Ohio belong to the Appalachian Province and lie entirely within the eastern part of the State. The areas formerly underlain by coal are estimated at 12,600 square miles, or about one-third of the entire State. There are 16 different beds, of which the more important are No. 1, or Sharon (block) coal; No. 2, or Wellston; No. 5, or Lower Kittanning; No. 6, or Middle Kittanning; No. 7, or Upper Freeport; No. 8, or Pittsburgh; Pomeroy; and Meigs Creek. All of these beds have been developed on a large scale. The other eight beds have been developed chiefly by small mines for local trade.

Coal No. 1, the block coal, is mined in the northeastern part of the State, principally in Mahoning, Stark, and Summit counties. It is a dry, free-burning, noncoking coal, very pure, and consumed, largely raw, in blast furnaces. This coal was the first mineral fuel to supplant charcoal in the blast furnaces of the State. As a domestic fuel

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it is known as Massillon coal and is highly prized for household use in Cleveland and other Lake cities. The annual production from this bed at the present time is about 600,000 tons. Twenty years ago, in 1892, the production exceeded 1,200,000 tons, indicating that this coal in that particular area is being worked out.

The No. 2, or Wellston coal, lies above the block (or No. 1) and has its highest development in the southwestern part of the Ohio field. The principal mining operations are at Jackson and Wellston, in Jackson County, whose production in 1913 was 587,044 short tons. This coal also appears to be approaching exhaustion, as in 1892 the production of Jackson County was 1,833,910 tons, and as late as 1906 it amounted to 1,370,000 tons.

Bed No. 5 (Lower Kittanning) is extensive, having been traced from Mahoning County, in the northeastern part of the State, to Lawrence County, at the southwestern extremity of the Ohio field. It is not extensively mined, however, being of workable thickness and quality in but few places. The principal mining operations are in Lawrence County, which had a total production of 176,098 tons in 1913, and part of this was probably from the No. 7 bed.

No. 6 (or Middle Kittanning) yields the justly celebrated Hocking Valley coal mined extensively in Athens, Hocking, and Perry counties. Like the block, it is a free-burning, noncoking coal, chiefly popular as a blast-furnace fuel, for which purpose it is used raw, but it is also highly regarded as a steam and domestic coal. The production of the three counties mentioned was 8,824,820 tons in 1913. In 1892 the same counties produced 4,640,647 tons. A small part of the Athens County production may be credited to the Pittsburgh (No. 8) bed, which is present in the county, and some little of Perry County's output may be from No. 7.

Bed No. 7, the Upper Freeport, mined in Gallia, Guernsey, Lawrence, and Muskingum counties and in portions of Perry County, is a high-grade steam fuel, and except for its content of sulphur would make an excellent coke. No coke is made from this bed in Ohio, however. The production of the three counties (Gallia, Guernsey, and Muskingum) from this bed in 1913 was 4,806,550 short tons.

No. 8, the Pittsburgh bed, is the most extensive and valuable in North America, underlying considerable portions of Pennsylvania, Maryland, West Virginia, and Ohio. Its area in Ohio probably amounts to over 1,000 square miles and it is extensively mined in Belmont, Jefferson, Harrison, and Noble counties, and to less extent in Athens, Gallia, Guernsey, Meigs, Monroe, and Morgan counties. The production of the first four counties, mostly Pittsburgh coal, in 1913, was 17,132,543 short tons. To this may be added about 500,000 tons mined in other counties. How the development of this coal has progressed in 20 years is shown by the fact that the four counties which produced over 17,000,000 tons in 1913 produced only 1,973,697 tons in 1892.

The Pomeroy bed, correlated with the Redstone of Pennsylvania, lies a short distance above the Pittsburgh and is worked in Gallia, Lawrence, and Meigs counties, the most of the production of Meigs County being from this bed.

The Meigs Creek coal, 80 to 100 feet above the Pittsburgh bed, is correlated with the Sewickley bed of western Pennsylvania. It is

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workable in portions of Morgan, Noble, Washington, Muskingum, Harrison, Belmont, and Monroe counties, and will ultimately prove a most valuable reserve, though its variable thickness and lower grade subordinate it to the Pittsburgh, and its exploitation is at present local and generally on a small scale.

One of the early reports published by Ohio states that in 1838 there were 119,952 short tons produced in the coal mines of the State. It is probable that some coal was mined in Ohio prior to that date, but there is no record of such production. The United States census of 1840 credited Ohio with an output of 140,536 tons of coal. The census of 1850 did not consider the coal-mining industry, and the next report of coal production in the State was that of the census of 1860, which recorded an output of 1,265,600 short tons.

A statement of the annual production of coal in Ohio from 1838 to the close of 1913 will be found in the following table:

Production of coal in Ohio from 1838 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1838	119,952	1858	1,000,000	1878	5,500,000	1898	14,516,867
1839	125,000	1859	1,060,000	1879	6,000,000	1899	16,500,270
1840	140,536	1860	1,265,600	1880	6,008,595	1900	18,988,150
1841	160,000	1861	1,150,000	1881	9,240,000	1901	20,943,807
1842	225,000	1862	1,200,000	1882	9,450,000	1902	23,519,894
1843	280,000	1863	1,204,581	1883	8,229,429	1903	24,838,103
1844	340,000	1864	1,815,622	1884	7,640,062	1904	24,400,220
1845	390,000	1855	1,536,218	1885	7,816,179	1905	25,552,950
1846	420,000	1866	1,887,424	1886	8,435,211	1906	27,731,640
1847	480,000	1867	2,092,334	1887	10,300,708	1907	32,142,419
1848	540,000	1868	2,475,844	1888	10,910,951	1908	26,270,639
1849	600,000	1869	2,461,986	1889	9,976,787	1909	27,939,641
1850	640,000	1870	2,527,285	1890	11,494,506	1910	34,209,668
1851	670,000	1871	4,000,000	1891	12,868,683	1911	30,759,986
1852	700,000	1872	5,315,294	1892	13,562,927	1912	34,528,727
1853	760,000	1873	4,550,028	1893	13,253,646	1913	36,200,527
1854	800,000	1874	3,267,585	1894	11,909,856		
1855	890,000	1875	4,864,259	1895	13,355,806	Total	682,678,546
1856	930,000	1876	3,500,000	1896	12,875,202		
1857	975,000	1877	5,250,000	1897	12,196,942		

OKLAHOMA.

Total production in 1913, 4,165,770 short tons; spot value, $8,542,748.

Oklahoma, more than any of the coal-producing States in the Mississippi Valley and the Rocky Mountain regions, was benefited by the labor troubles in Colorado, as is shown by an increase in production from 3,675,418 short tons in 1912 to 4,165,770 tons in 1913. The gain in output was 490,352 tons, or 13.34 per cent; the value of the product increased from $7,867,331 to $8,542,748, a gain of $675,417, or 8.6 per cent. The smaller relative gain in value in 1913 was due to the fact that in 1912 prices were somewhat inflated because of the rather abrupt withdrawal of fuel oil from the markets where it had been in competition with Oklahoma coal and to a diminution in the supply of natural gas from the northern part of the Mid-Continent field, particularly in Kansas. The average value per ton of Oklahoma coal advanced from $2.05 in 1911 to $2.14 in 1912. The deficiency in the Kansas production of natural gas is being made

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up, however, by developments in Oklahoma, and the result of this and of the supply of coal catching up with the demand by the increased production in 1913 is exhibited in the return to the lower prices of 1911. The average value per ton in 1913 was the same as in 1911. Oklahoma, being nearer than Arkansas to the markets usually supplied with Colorado coal, was called upon to a greater extent to supply the deficiency caused by the strike conditions in the Rocky Mountain State; otherwise what has been said concerning weather, transportation, and labor conditions in Arkansas applies with about equal force to Oklahoma, except that less time was lost in Arkansas than in Oklahoma by labor troubles. The total number of men on strike in Oklahoma in 1913 was 1,696, and the average time lost by each was 80 days.

Oklahoma continues to show a disgracefully high percentage of coal shot off the solid, a practice encouraged by the laws of the State which compel the payment of wages on the basis of mine-run coal. An increase in the production of machine-mined coal from 259,719 tons, or 7.1 per cent of the total, in 1912, to 670,629 tons, or 16.1 per cent of the total, in 1913, reduced the percentage of coal shot off the solid from 86.4 to 81, but at the same time the quantity of "powder-mined" coal increased nearly 200,000 tons, from 3,175,455 tons in 1912 to 3,371,218 in 1913, so the record for the latter year can hardly be considered much of an improvement over 1912.

The number of days the men were able to work in 1913 shows a marked improvement over the two preceding years, and if no time had been lost by strikes the average number of days worked would have exceeded 200 by a good margin. As it was, the average time made by the 9,044 men employed was 197 days, as compared with 8,785 men for 174 days in 1912 and 8,790 men for 156 days in 1911. The average total production per man in 1913 was 461 tons, against 418 tons in 1912, but the average daily production by each employee fell off slightly, from 2.4 to 2.34.

The fatality record for Oklahoma in 1913, according to the Bureau of Mines, shows a decided improvement over 1912, when, owing to explosion of gas and dust in the San Bois mine at McCutcheon, the death toll was high. In that one explosion the lives lost amounted to more than three times the total number of deaths in 1913, when 23 fatal accidents occurred. Falls of roof and coal claimed 7 victims in 1913, the same number of deaths as in 1912; 6 deaths were due to haulage-way accidents, 4 to careless use of explosives, and 6 to miscellaneous causes. The death rate per thousand was 2.54 in 1913, and the number of tons mined for each life lost was 181,120.

The statistics of production in 1912 and 1913, by counties, with the distribution of the product for consumption, are shown in the following table:

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Coal production of Oklahoma in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Coal	766,099	13,611	36,445	816,155	$1,805,804	$2.21	222	1,929
Haskell and Latimer	711,596	3,269	51,933	766,798	1,5o0,562	2.02	152	1,753
Le Flore	138,333	4,445	7,733	150,511	238,360	1.58	163	256
Okmulgee	605,532	12,493	11,964	629,989	1,123,473	1.78	158	1,120
Pittsburg	1,143,969	13,109	77,256	1,234,334	2,992,830	2.42	165	3,524
Tulsa	22,184	17,710	70	39,964	75,934	1.90	179	75
Other counties [a]	28,245	2,511	.....	30,756	63,061	2.05	178	128
Small mines	.....	6,911	.....	6,911	17,307	2.50	.....	.....
Total	3,415,958	74,059	185,401	3,675,418	7,867,331	2.14	174	8,785

1913.

Coal	828,158	10,434	50,707	889,299	$1,948,204	$2.19	232	2,049
Haskell & Latimer	673,077	4,930	60,672	738,679	1,455,810	1.97	171	1,491
Le Flore	185,303	4,141	12,409	201,853	321,857	1.59	161	358
Okmulgee	803,655	1,225	15,779	820,659	1,419,919	1.73	208	1,361
Pittsburg	1,295,560	8,418	125,372	1,429,350	3,225,836	2.26	188	3,556
Tulsa	27,168	24,972	160	52,300	101,905	1.95	208	108
Other counties [b]	28,175	2,792	100	31,067	63,634	2.05	195	121
Small mines	.....	2,563	.....	2,563	5,583	2.18	.....	.....
Total	3,841,096	59,475	265,199	4,165,770	8,542,748	2.05	197	9,044

[a] Atoka, Rogers, and Wagoner. [b] Rogers and Wagoner.

The production of coal, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912, is shown in the following table:

Coal production of Oklahoma in 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Coal	658,159	498,658	778,546	816,155	889,299	+ 73,144
Haskell and Latimer	738,806	675,953	701,374	766,798	738,679	− 28,119
Le Flore	128,376	87,628	122,468	150,511	201,853	+ 51,342
Okmulgee	262,310	227,107	408,202	629,989	820,659	+ 190,670
Pittsburg	1,271,109	1,083,243	1,018,742	1,234,334	1,429,350	+ 195,016
Rogers and Wagoner	14,556	27,618	18,784	30,126	31,067	+ 941
Tulsa	39,834	40,007	21,422	39,964	52,300	+ 12,336
Small mines	6,227	6,012	[a] 4,704	[b] 7,541	2,563	− 4,978
Total	3,119,377	2,646,226	3,074,242	3,675,418	4,165,770	+ 490,352
Total value	$6,253,367	$5,867,947	$6,291,494	$7,867,331	$8,542,748	+$675,417

[a] Includes Atoka and Johnston counties. [b] Includes Atoka County.

The coal areas of Oklahoma belong to the western interior coal field. They lie entirely in the eastern and northeastern part of the State, forming the connection between the Kansas fields on the north and the Arkansas fields on the east. The principal developments are in the southern portion of the field in what was formerly the Choctaw Nation of the Indian Territory and is now included within the counties of Coal, Haskell, Latimer, and Pittsburg. The

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total area underlain by workable coal is estimated at about 10,000 square miles. The coals, of which there are 10 or more beds, range from a medium-grade to a high-grade bituminous, some of the latter approaching semianthracite. Coking qualities are present in some of the higher grades, but efforts to make coke in the several hundred beehive ovens constructed for that purpose have not been conspicuously successful. Transportation and a considerable portion of the markets for the coals of Oklahoma are furnished by the Missouri, Kansas & Texas, the St. Louis & San Francisco, the Kansas City Southern, and the Rock Island Railway systems.

The Tenth United States Census (1880) contains the first published record of coal production in Oklahoma (Indian Territory), although as a small quantity of coal was mined in Arkansas as early as 1840, it is probable that some was produced in the Territory earlier than 1880. The maximum production (4,165,770 short tons) was mined in 1913, although, as shown in the following table, the industry during the last 10 years has been practically stationary, and has not shown the development and progress exhibited in other States:

Production of coal in Oklahoma from 1880 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1880	120,947	1889	752,832	1898	1,381,466	1907	3,642,658
1881	150,000	1890	869,229	1899	1,537,427	1908	2,948,116
1882	200,000	1891	1,091,032	1900	1,922,298	1909	3,119,377
1883	350,000	1892	1,192,721	1901	2,421,781	1910	2,646,226
1884	425,000	1893	1,252,110	1902	2,820,666	1911	3,074,242
1885	500,000	1894	969,606	1903	3,517,388	1912	3,675,418
1886	534,580	1895	1,211,185	1904	3,046,539	1913	4,165,770
1887	685,911	1896	1,366,646	1905	2,924,427		
1888	761,986	1897	1,336,380	1906	2,860,200	Total	59,474,164

OREGON.

Total production in 1913, 46,063 short tons; spot value, $116,724.

The only productive coal field in Oregon is situated in the southwestern part of the State, in Coos County, and is known as the Coos Bay field, from the fact that it entirely surrounds that body of water. It occupies a total area of about 230 square miles, its length north and south being about 30 miles and its maximum breadth at the middle about 11 miles, tapering regularly toward both ends. Other coal fields have been prospected in different parts of the State. Among them are the upper Nehalem field, in Columbia County; the lower Nehalem, in Clatsop and Tillamook counties; the Yaquima field, in Lincoln County; the Eckley and Shasta Costa fields, in Curry County; the Eden field, in Coos County, and the Rogue River Valley field, in Jackson County. All of these fields lie west of the Cascade Range, but none has been developed to the point of production. Another field has been located in the basin of John Day River, east of the Cascade Range, but little is known concerning it. All of the fields west of the range, with the exception of the Coos Bay, are of small area, the largest, outside of the Coos Bay, being the upper Nehalem, which has an area of less than 20 square miles. All of the coal of these fields is lignitic in character, except the best coals of Coos Bay, which are properly regarded as subbituminous. Transportation is

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confined exclusively to Coos Bay and the Pacific Ocean, and San Francisco is the principal market.

The production of coal in Oregon has never been one of the important industries of the State, and has been of less importance during the last few years than formerly because of the large increase in the production of petroleum in California and in its use for fuel. Before the advent of the liquid fuel considerable quantities of Oregon coal were shipped to San Francisco, where it served to some extent as a moderator of prices, particularly for domestic fuel. In only four years, however, has the production exceeded 100,000 tons, and in each of the last three years it has been below 50,000 tons. The production in 1913 of 46,063 tons was an increase of 4,426 tons over 1912, but a little less than the output of 1911.

The statistics of production in Oregon, with the distribution of the product for consumption during the last five years, are shown in the following table:

Distribution of coal production of Oregon, 1909–1913, in short tons.

Year.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
1909	44,236	25,700	17,340	87,276	$235,085	$2.69	.....	235
1910	40,497	13,583	13,453	67,533	235,229	3.48	257	153
1911	22,407	10,216	14,038	46,661	108,033	2.32	179	189
1912	14,361	19,645	7,630	41,637	108,276	2.60	239	222
1913	31,582	8,617	5,864	46,063	116,724	2.53	283	203

Coal was first noted in the Coos Bay region about 60 years ago, Prof. J. S. Newberry having reported in 1855 that the coal deposits of Coos Bay had begun to attract attention.

The first cargo was shipped from the Empire Basin, but the discovery of coal near the head of Coos Bay soon transferred the point of production to Newport, which remained the principal mine until within the last decade, since the Beaver Hill mine has been more successfully managed and become the chief producer. The first record of coal production is contained in the census report of 1880, when 43,205 short tons were mined.

The total production of coal in Oregon to the close of 1913 has amounted to 2,165,821 short tons, as shown in the following table:

Production of coal in Oregon, 1880–1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1880	43,205	1889	64,359	1898	58,184	1907	70,981
1881	33,600	1890	61,514	1899	86,888	1908	86,259
1882	35,000	1891	51,826	1900	58,864	1909	87,276
1883	40,000	1892	34,661	1901	69,011	1910	67,533
1884	45,000	1893	41,683	1902	65,648	1911	46,661
1885	50,000	1894	47,521	1903	91,144	1912	41,637
1886	45,000	1895	73,685	1904	111,540	1913	46,063
1887	37,696	1896	101,721	1905	109,641		
1888	75,000	1897	107,289	1906	79,731	Total	2,165,821

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PENNSYLVANIA.

Total production in 1913, 265,306,139 short tons; spot value, $388,220,933.

Anthracite.—Total production in 1913, 81,718,680 long tons (equivalent to 91,524,922 short tons); spot value, $195,181,127.

Bituminous.—Total production in 1913, 173,781,217 short tons; spot value, $193,039,806.

In the production of both anthracite and bituminous coal in 1913 Pennsylvania exceeded all previous records, the combined production of 265,306,139 short tons being larger than that of 1912, the year of previous maximum production, by 19,079,053 short tons, or 7.7 per cent. The percentage of increase was nearly the same for both bituminous coal and anthracite, the former showing an increase of 11,915,729 short tons, or 7.4 per cent, and the latter a gain of 6,395,825 long tons (equivalent to 7,163,324 short tons), or 8.5 per cent. Prices for bituminous coal showed larger advances, however, than those for anthracite, and the gain in value for the bituminous product was $23,669,309, or 14 per cent, whereas the value of anthracite increased $17,558,501, or 9.9 per cent. The combined value of $388,220,933 exceeded that of 1912 by $41,227,810, or 11.9 per cent. It will be observed that in proportion to the output the value of anthracite greatly exceeds that of bituminous coal. In 1913 the prices for bituminous coal in Pennsylvania were unusually high, and yet, although the production of bituminous coal was more than twice as much as anthracite, the value of the latter exceeded the value of the bituminous product by more than $2,000,000.

The magnitude of the coal-mining industry in Pennsylvania, as represented by the output of the anthracite and bituminous mines, is little realized. The combined production of 265,306,139 short tons in 1913 exceeded by more than 20 per cent the total production of the United States in 1898, 15 years before, and was more than two and one-half times the country's total production in 1882, the year for which the first volume of the series, "Mineral Resources of the United States," was published. Pennsylvania's production of coal, anthracite and bituminous combined, exceeds that of any other country in the world, except Great Britain and Germany, and approaches within less than 10 per cent of the latter. In 1913 it was nearly five times the production of the Austro-Hungarian Empire (next to Germany in coal-producing importance), nearly six times that of France, nine times that of Russia and Finland, and ten times that of Belgium. It is equal to nearly 20 per cent of the world's total production, and exceeds the combined output of all the countries of the world, leaving out Great Britain, Germany, and the United States. The combined value of the anthracite and bituminous coal produced in Pennsylvania in 1913 was more than 15 per cent of the value of the total mineral production of the United States in that year and was equal to 87 per cent of the total mineral production in 1893. From 1829 to and including the first year of the present century Pennsylvania contributed over 50 per cent of the total coal production of the United States and still produces between 45 and 50 per cent of the total, but the relative importance of Pennsylvania as a coal producer has steadily declined in recent years. Whereas in 1880 Pennsylvania produced 66 per cent of the total, in 1890 its percentage was 56; in 1900 it was 51; in 1910 it was 46.9; in 1911 it

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was 47.4; in 1912 it was 46.1; and in 1913 it was 46.6. The smaller percentage in the later years as compared with the earlier must not be taken as an indication of any decline in the coal-mining industry of Pennsylvania, for that industry has, particularly in the bituminous districts, kept pace with the manufacturing industries and has increased in considerably larger ratio than the population of the State and of the United States as a whole. The falling off in the relative importance of Pennsylvania has been due to the more rapid increase in the production of other States—notably West Virginia, Illinois, Alabama, and the Rocky Mountain States.

The following table shows the total production of the United States and of Pennsylvania since 1880, with the percentage of the total tonnage produced by Pennsylvania in each year:

Production of Pennsylvania coal compared with total production of the United States, 1880–1913, in short tons.

Year.	Total United States.	Pennsylvania.	Percentage of Pennsylvania to total.	Year.	Total United States.	Pennsylvania.	Percentage of Pennsylvania to total.
1880	71,481,370	47,074,075	66	1897	200,223,665	107,029,654	53
1881	85,881,030	54,320,018	63	1898	219,976,267	118,547,777	54
1882	103,285,789	57,254,307	55	1899	253,741,192	134,568,180	53
1883	115,212,125	62,488,190	54	1900	269,684,027	137,210,241	51
1884	119,735,051	62,404,488	52	1901	293,299,816	149,777,613	51
1885	110,957,522	62,137,271	56	1902	301,590,439	139,947,962	46
1886	112,743,403	62,857,210	56	1903	357,356,416	177,724,246	49.7
1887	129,975,357	70,372,857	54	1904	351,816,398	171,094,996	49
1888	148,659,402	77,719,624	52	1905	392,722,635	196,073,487	49.9
1889	141,229,514	81,719,059	58	1906	414,157,278	200,575,617	48.4
1890	157,770,963	88,770,814	56	1907	480,363,424	235,747,489	49.1
1891	168,566,668	93,453,021	55	1908	415,842,698	200,448,281	48.2
1892	179,320,071	99,167,080	55	1909	460,814,616	219,037,150	47.5
1893	182,352,774	98,038,267	54	1910	501,596,378	235,006,762	46.9
1894	170,741,526	91,833,584	54	1911	496,371,126	235,025,324	47.4
1895	193,117,830	108,216,355	56	1912	534,466,580	246,227,086	46.1
1896	191,986,357	103,903,334	54	1913	570,048,125	265,306,139	46.6

There was a decided gain in 1913 in the number of working days made by the employees in both the anthracite and the bituminous mines, the former making an average of 257 days, as compared with 231 days in 1912, and the latter, 267 days, as compared with 252 days in 1912. The anthracite mines gave employment to 175,745 men and the bituminous mines to 172,196 men. The unusually large number of working days enabled the employees to make exceptionally high records in the number of tons produced per man for the year, but, as is frequently the case when more opportunity is given for working a larger number of days, the average daily production per man was less. The bituminous workers established a new record for tonnage per employee, with an average of 1,009 tons each. The anthracite workers averaged 465 long tons (or 520 short tons). The average daily tonnage per man in the bituminous fields was 3.78 in 1913, against 3.89 in 1912 and 3.69 in 1911. The average daily tonnage per man in the anthracite region has decreased steadily since 1910 from 2.17 short tons in that year to 2.13 tons in 1911, to 2.10 tons in 1912, and to 2.02 tons in 1913.

It is pretty generally conceded by those interested in the production of anthracite that the limit of annual production has about been reached and that the yearly output will remain fairly constant until the period of decline begins. Some have expressed the opinion

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that the yearly production will exceed 100,000,000 tons before the limit is reached, but the opinion is not shared by many. Anthracite as a manufacturing fuel has been eliminated, and the increasing use of coke and gas (particularly the latter) for domestic purposes in the territory supplied by anthracite coal is keeping approximately in step with the increase in population. In the larger cities the tendency toward apartment-house residence is growing rapidly, as compared with the individual homes; and as the former are largely heated by steam raised by bituminous coal, and furnished with gas ranges for cooking, it can not be seen where the expanding markets for anthracite are to be obtained.

The following table shows the average production of Pennsylvania anthracite and of bituminous coal in the United States, by five-year periods, from 1876 to 1910, and for the three years, 1911–1913, with the percentage that each bears to the total. It will be observed from this table that the average annual production of anthracite during the last five years of this period (1906 to 1910) was 3.1 times the average yearly production from 1876 to 1880. The average annual bituminous production in the five years from 1906 to 1910 was 10.4 times that of the first five years. The percentage of anthracite production to the total has decreased steadily from 41.44 per cent in the five years from 1876 to 1880 to 16.6 per cent in the three years from 1811 to 1913. On the other hand, the percentage of bituminous production to the total has increased from 58.56 in the period from 1876 to 1880 to 83.4 in the three years from 1911 to 1913.

Production of anthracite and bituminous coal since 1876, by averages of five-year periods, in short tons.

Period.	Anthracite.		Bituminous.	
	Quantity.	Percentage of total.	Quantity.	Percentage of total.
1876–1880	25,800,169	41.44	36,460,776	58.56
1881–1885	36,198,188	33.74	71,092,930	66.26
1886–1890	43,951,763	31.76	94,446,451	68.24
1891–1895	53,405,187	29.87	125,416,327	70.13
1896–1900	55,625,265	24.49	171,498,143	75.51
1901–1905	66,853,778	19.70	272,503,363	80.30
1906–1910	81,142,214	17.85	373,412,644	82.15
1911–1913	88,783,529	16.6	444,845,081	83.4

It is interesting to note how the production of anthracite and of bituminous coal has increased in comparison with the growth in population. This is shown in the following table. It will be observed that from 1880 to 1913 the per capita production of anthracite has increased from 0.57 ton to 0.94 ton, while that of bituminous coal has increased from 0.85 ton to 4.93 tons.

Production of anthracite and bituminous coal per capita of population, 1880–1913, in short tons.

Year.	Population.	Production of anthracite.		Production of bituminous.	
		Quantity.	Per capita.	Quantity.	Per capita.
1880	50,189,209	28,649,812	0.57	42,831,758	0.85
1890	63,069,756	46,468,641	.74	111,302,322	.76
1900	76,303,387	57,367,915	.75	212,316,112	2.78
1910	91,972,266	84,435,236	.92	417,111,142	4.54
1911	[a] 93,927,342	90,464,067	.96	405,907,059	4.32
1912	[a] 95,545,336	84,361,598	.88	450,104,982	4.71
1913	[a] 97,163,330	91,524,922	.94	478,523,203	4.93

[a] Estimated by Bureau of the Census.

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Anthracite mining began between 1790 and 1800, when a small quantity was produced for local consumption. The first shipment was made from the Wyoming region in 1807, when 55 tons were sent from Plymouth to Columbia. Between then and 1820, when the first shipments were sent out from the Lehigh region, it is estimated that approximately 10,000 long tons were produced. To the close of 1913 the total production of anthracite had amounted to 2,184,550,009 long tons, or 2,446,696,010 short tons.

The first records of bituminous-coal production in Pennsylvania cover the year 1840, when 464,826 short tons were mined. The total output of bituminous coal from 1840 to the close of 1913 has amounted to 2,731,945,059 short tons, from which it appears that the total production of bituminous coal in Pennsylvania has exceeded that of anthracite by something over 285,000,000 short tons.

PENNSYLVANIA ANTHRACITE.

The production of anthracite in Pennsylvania in 1913 exceeded the best previous output by nearly a million tons, and established a new record for the region. Including the coal recovered from old culm banks by washeries and a small quantity dredged from Susquehanna River, the production of anthracite in 1913 amounted to 81,718,680 long tons, valued at $195,181,127. In 1912, when mining opeartions were suspended from April 1 until the latter part of May, pending the adjustment of the wage scale, the production was 75,322,855 long tons, valued at $177,622,626, compared with which the record for 1913 shows an increase of 6,395,825 long tons, or 8.5 per cent, in quantity, and of $17,558,501, or 9.9 per cent in value. Prior to 1913 the maximum production was that made in 1911—80,771,488 long tons, valued at $174,952,415. That was exceeded in 1913 by 947,192 long tons in quantity and by $20,228,712 in value. When, about June 1, 1912, mining operations were resumed, it was under an agreement which reextended, with some modifications, the awards of the Anthracite Coal Strike Commission, which had been in force through renewals by mutual consent since the expiration of the original awards, March 31, 1906. In consequence of the miners and operators again extending the terms of the awards, this time for a period of four years, there were no serious interruptions to coal-mining operations by labor troubles in 1913, and industrial peace is assured in the anthracite region until 1916. No exceptional influences affected the anthracite trade in 1913, the somewhat unusual gain in tonnage over 1912 being the natural result of the reduced output in that year; nor was any difficulty experienced in transportation, the mild winter of 1912–13 and the favorable weather in November and December, 1913, being all that could be asked, although they may not have created a demand such as the coal dealers and producers desire. As the use of anthracite as a manufacturing fuel has been eliminated, it is not affected to the same extent as bituminous coal by trade conditions, the principal influence being the temperature during the winter months. The increase in the use of artificial gas and of coke for domestic purposes will probably keep pace with the increase of population in the markets supplied by anthracite, and there is little probability that the production of anthracite will show any marked increase in the future.

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Changes in temperature and labor conditions will continue to be the most important factors affecting the production of anthracite.

The most notable feature of the anthracite trade in 1913 was the decreased tonnage recovered by washeries from the old culm banks, that item in 1913 being less than in 1912 by more than a million tons, or about one-third. To this fact is due in part, at least, the advance of 3 cents in the average value per ton from $2.36 in 1912 to $2.39 in 1913. The major part of the washery product consists of pea, buckwheat, rice, and barley, and all of it sells at much lower prices than coal fresh from the mine and breaker. Since the first washery was constructed, in 1890, the total recovery for shipment of usable fuel from the waste heaps or culm banks has amounted to 49,329,376 long tons, and the decline in their productivity is not difficult to understand. These figures represent shipments only. They do not include the washery product sold locally or used at the collieries, of which no record is made. The maximum washery production was made in 1907, when 4,301,082 tons were recovered for shipment. It has shown a decreasing tendency since that date, falling in six years to less than one-half the maximum of 1907. In discussing the washery product it should be remembered that only that coal recovered from the culm banks is considered. "Washery" product does not include any freshly mined coal that passes through a washery operated in connection with the breakers. The decrease in washery output is reflected in a decrease in the percentage of small sizes in 1913, as compared with any of the eight preceding years, although in quantity the small sizes in 1913 exceeded that of 1912 by about 1,700,000 tons.

The total shipments [1] from the anthracite region, reported to the United States Geological Survey for 1913 were 71,295,716 long tons, of which 43,934,919 tons, or 61.6 per cent, consisted of the prepared or domestic sizes, and 27,360,797 tons, or 38.4 per cent, consisted of pea, buckwheat, rice, barley, and screenings. In the last few years pea coal has become an important factor in the domestic trade, particularly for household furnaces, and probably should be included among the prepared sizes. It is no longer sold below the cost of production as are the smaller sizes with which it has been customary to include it. The circular price per long ton for pea coal at the mines in 1912 and 1913 was $2.50; buckwheat was quoted at $1.50 a ton. The average price per ton for rice in 1913 was 65.4 cents, and for barley 40.2 cents.

Of the total production of 81,718,680 long tons in 1913, 71,343,172 tons, or 87.3 per cent, were loaded at the mines for shipment to distant points, 1,793,814 tons, or 2.2 per cent, were sold to local trade or used by employes, and 8,581,694 tons, or 10.5 per cent, were consumed in the generation of heat and power at the collieries. Prior to 1907, the quantity of coal consumed at the collieries was included in the production, but no value was placed upon it. In 1907 and 1908 an arbitrary value of 20 cents a ton was given this factor. Since and including 1909 the colliery consumption has been assumed to have the same value as similar coal placed upon the market. When it is apparent from the schedules returned to the Survey that the values reported include only the coal sold, the colliery consumption has been valued at 50 cents a ton. In the earlier days of anthracite

[1] Only shipments of anthracite are reported by sizes. Coal sold to local trade and the colliery consumption are not so reported.

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mining the colliery consumption consisted of a portion of the product which otherwise would have gone to the culm banks. Nowadays there is a market for almost any grade of anthracite that will burn. No more coal goes to the culm banks except for temporary storage and subsequent recovery by washeries. The old culm banks themselves are contributing their share to the total production, and these unsightly monuments to former waste are rapidly disappearing. Even the waste from the culm-bank washeries is being made to serve a useful purpose, as it is flushed into the mines and partly fills old workings, where it cements together and furnishes supports to the roof when the coal previously left for pillars is removed. This utilization of the waste prevents, too, the injury to farm lands in the valleys, a serious cause of complaint among the farmers when, as in earlier days, the waste from the washeries was spread over their lands in flood seasons.

Another record in addition to that of tonnage and value was established in the anthracite region in 1913. The average working time, 257 days, exceeded anything in the history of the region, the nearest approach to this record being in 1911, when an average of 246 working days was made. In 1912, despite the seven-weeks' shut-down, the men averaged 231 working days during the year. The average number of men employed in the anthracite mines in 1913 was 175,745, against 174,030 men in 1912. The larger number of days worked in 1913 resulted in a larger average tonnage per man for the year, but the average daily production by each employee was less. In 1912 the average output per man for the year was 434 long tons; in 1913 it was 466 tons. The average daily tonnage per man has decreased steadily since 1910 from 1.94 in that year to 1.9 in 1911, 1.88 in 1912, and 1.81 in 1913.

Reports to the Bureau of Mines show that there were 618 fatal accidents in the anthracite mines in 1913, the principal contributing causes and the number of deaths from them being falls of roof and coal, 257; mine cars and locomotives, 85 underground and 35 on the surface; gas explosions, 50; explosions of powder, etc., 75; falls in shafts, 30. The death rate per 1,000 employees was 3.52, and the coal mined for each life lost was 132,231 tons. In 1912 the death rate was 3.4, and the quantity of coal mined for each fatality was 128,977 tons.

The statistics of anthracite production during the last six years are presented in the following table:

Statistics of anthracite production, 1908–1913.

Year.	Quantity (long tons).	Value.	Average price per ton.	Average number of men employed.	Average number of days worked.
1908	74,347,102	$158,178,849	$2.13	174,174	200
1909	72,384,249	149,181,587	2.06	[a]171,195 / [b]166,801	205
1910	75,433,246	160,275,302	2.12	169,497	229
1911	80,771,488	174,952,415	2.17	172,585	246
1912	75,322,855	177,622,626	2.36	174,030	231
1913	81,718,680	195,181,127	2.39	175,745	257

[a] State mining department figures. [b] U. S. Census figures.

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The production, by counties, in 1912 and 1913, with the distribution of the product for consumption, is shown in the following table:

Anthracite production in 1912 and 1913, by counties, in long tons.

1912.

County.	Shipped.	Sold to local trade and employees.	Used at mines for steam and heat.	Total.
Carbon	2,163,896	118,852	285,557	2,568,305
Columbia	936,704	15,684	127,478	1,079,866
Dauphin	625,570	21,594	196,677	843,841
Lackawanna	16,901,030	644,797	1,737,987	19,283,814
Luzerne	24,645,483	822,840	2,821,556	28,289,879
Northumberland	5,238,591	116,320	665,529	6,020,440
Schuylkill	13,676,628	299,802	2,062,077	16,038,507
Sullivan	534,004	7,597	38,072	579,673
Susquehanna and Wayne	479,347	9,594	43,867	532,808
River dredges	28,002	56,824	896	85,722
Total	65,229,255	2,113,904	7,979,696	75,322,855

1913.

Carbon	2,600,127	111,227	354,960	3,066,314
Columbia	922,532	16,136	139,813	1,078,481
Dauphin	712,349	20,048	214,273	946,670
Lackawanna	18,022,318	450,949	1,767,223	20,240,490
Luzerne	27,713,933	731,667	3,093,779	31,539,379
Northumberland	5,447,529	116,290	697,683	6,261,502
Schuylkill	14,859,215	252,526	2,216,925	17,328,666
Sullivan	537,404	7,509	48,000	592,913
Susquehanna and Wayne	480,309	7,865	42,105	530,279
River dredges	47,456	79,597	6,933	133,986
Total	71,343,172	1,793,814	8,581,694	81,718,680

The circular prices of anthracite at the mines during the last four years, according to sizes, are shown in the following table. These prices are common for the entire region, except for rice and barley, which are not included in the circular. Prices quoted for these sizes are the average, as reported by the Philadelphia & Reading Coal & Iron Co. on actual sales:

Circular prices for anthracite at the mines, 1910–1913, per long ton.

Size.	1910	1911	1912	1913
Lump	$3.50	$3.50	$3.50	$3.50
Steamboat	3.00	3.00	3.00	3.00
Broken (furnace)	[a] 3.50	[a] 3.50	[b] 3.50	3.50
Egg	[a] 3.75	[a] 3.75	[b] 3.75	3.75
Stove	[a] 3.75	[a] 3.75	[b] 4.00	4.00
Chestnut	[a] 3.75	[a] 4.00	[b] 4.15	4.15
Pea	2.00	2.00	2.50	2.50
Buckwheat	1.50	1.50	1.50	1.50
Rice	.....	[c].538	[c].634	.654
Barley	.....	[c].339	[c].388	.402

[a] Subject to 50 cents reduction in April, 40 cents in May, 30 cents in June, 20 cents in July, and 10 cents in August.
[b] Discounts omitted in April and May, but resumed in June.
[c] Average price received for all coal of these sizes sold by Philadelphia & Reading Coal & Iron Co.

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Circular prices of anthracite at New York Harbor ports and at Port Richmond (Philadelphia) in 1912 and 1913 were as follows:

Circular prices for free-burning, white-ash anthracite f. o. b. New York Harbor ports and Port Richmond in 1912 and 1913, per long ton.

Size.	New York Harbor.		Port Richmond.	
	1912	1913	1912	1913
Broken [a]	$5.00	$5.00	$4.75	$4.75
Egg [a]	5.25	5.25	5.00	5.00
Stove [a]	5.25	5.25	5.00	5.00
Chestnut [a]	5.50	5.50	5.25	5.25
Pea	[b] 3.35	3.35	3.197	3.284
No. 1, buckwheat	2.45	2.45	2.296	2.25
No. 2, buckwheat	[c] 1.95	1.94	1.815	1.85
No. 3, buckwheat	[c] 1.548	1.62	1.50	1.45

[a] Philadelphia & Reading Coal & Iron Co. circular.
[b] Lehigh Coal & Navigation Co. quotations.
[c] Average prices f. o. b.

Since 1901 it has been customary to allow discounts from the circular prices during the spring in order to induce consumers to buy their supplies for the following winter during the summer months, when ordinary demand is light and when operations and transportation are not liable to interruption by inclement weather. The wisdom of this policy has been clearly evinced by the marked increase in the number of working days the employees have been able to make and in the uniform distribution of the shipments throughout the 12 months of the year. The effect upon the working time is exhibited by the fact that in the 10 years from 1892 to 1901 the mean average time worked in the anthracite regions was 179 days, with a range from 150 days in 1897 to 198 days in 1892. The year of the great anthracite strike, 1902, is excluded from the comparison, as in that year conditions were abnormal and only 116 days were made. Since 1902 the average number of working days has fallen below 200 in only one year, 1906, when there was a long suspension following the termination of the Anthracite Strike Commission's awards and pending their renewal. From this minimum of 195 days in 1906 the average has ranged as high as 257, in 1913, with a mean average for the 10 years of 220 days. The average working time in the later period exceeds that of the earlier by 23 per cent. Wage rates have been advanced 21 per cent (10 per cent in 1902 and 10 per cent more in 1912), from which it may be computed that the average yearly earnings in 1913 were nearly 45 per cent more than before the spring reductions went into effect and before the strike of 1902 resulted in the first 10 per cent advance in wages. In 1913 the railroad shipments reported to the Bureau of Anthracite Coal Statistics amounted to 69,069,628 long tons, of which 34,707,619 tons, or 50.3 per cent, were sent out during the winter months and 34,362,009 tons, or 49.7 per cent, in the summer months, the difference between the winter and summer shipments being less than 350,000 tons in a total exceeding 69,000,000. This statement shows that employment in the anthracite region is evenly distributed throughout the year, and when this is considered, with the increase in wages already referred to, it makes no straining stretch of credulity to believe the claim that in no time in its history has the

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anthracite region of Pennsylvania enjoyed such a period of peace and prosperity as that of the last 10 years.

The following table shows the shipments, by months, during the last five years, as reported by the Bureau of Anthracite Coal Statistics. The table does not include the shipments from Sullivan County nor the shipments of coal recovered from Susquehanna River:

Monthly shipments of anthracite, 1909–1913, in long tons.

Months.	1909	1910	1911	1912	1913
January	5,183,345	5,306,618	5,904,117	5,763,696	6,336,419
February	4,576,004	5,031,784	5,070,948	5,875,968	5,674,169
March	6,332,474	5,174,166	5,996,894	6,569,687	4,909,288
April	5,891,176	6,224,396	5,804,915	266,625	5,966,189
May	5,063,873	5,679,661	6,317,352	1,429,357	5,995,742
June	4,904,858	5,398,123	6,215,357	6,191,646	5,970,047
July	4,020,765	4,202,059	4,804,065	6,285,153	5,487,852
August	4,198,273	4,996,044	5,531,796	6,576,591	5,369,900
September	4,116,120	4,967,516	5,730,935	5,876,496	5,572,279
October	5,579,759	5,622,095	6,269,179	6,655,321	6,338,194
November	6,027,800	6,071,746	6,193,314	6,165,536	5,786,931
December	5,775,438	6,231,578	6,115,427	5,944,502	5,662,618
Total	61,969,885	64,905,786	69,954,299	63,610,578	69,069,628

In the report for 1912 it was stated that the disproportionate increase in the quantities of small sizes sent to market had come to an end, and the returns for 1913 bear out this assertion. The larger increase in the production of small sizes had been due to two causes: (1) The elimination of anthracite as a blast-furnace and steamer fuel, and (2) the working over of the old culm banks by washeries; the former necessitated the breaking down of lump coal, with the consequent quantity of smalls from such treatment, and much the larger part of the washery coal was below the size of nut coal. There is no further increase due to the breaking down of the larger coal, as it is now plactically all broken and sized, and the gradual disappearance of the crum banks as a source of coal is shown by the reduction in 1913 as compared with 1912 of nearly one-third in the washery product.

The probability is that the proportions of prepared and small sizes will remain fairly steady. From 1890 to 1907 there was a marked increase in the output of steam sizes compared with the production of the prepared or domestic sizes, as shown by the fact that in the earlier years the shipments of anthracite represented by the sizes above pea coal were 76.9 per cent of the total and that 23.1 per cent was made up of pea coal and smaller. In 1907 the percentage of the sizes above pea coal had fallen to 58.6, and that of pea coal and smaller had increased to 41.4 per cent. The smallest percentage in the shipments of domestic sizes was in 1909, when these constituted 58.1 per cent of the total, while the steam sizes represented 41.9 per cent. Since 1909 the proportion of the shipments made up from pea coal and smaller has grown steadily less. Inclusive of washery output the percentages of steam sizes in 1911, 1912, and 1913 were respectively 40.8, 39.4, and 38.4, the proportions of domestic sizes increasing correspondingly. Exclusive of washery coal the percentages of shipments of small sizes during the last three years were 38 in 1911, 36.5 in 1912, and 36.7 in 1913. Owing to the suspension in the spring of 1912, the washery shipments showed a relative gain, though the quantity shipped was a little less than in 1911.

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The first washery was installed in 1890, and 41,600 long tons of coal thus recovered were shipped in that year. In 1907 this recovery had increased to 4,301,082 tons. From this maximum the percentage of washery product has declined each year and in 1913 was less than half that of 1907. About the time that washeries were introduced to recover this small coal from the culm banks they were also installed at the breakers, with the result that the small sizes, instead of being thrown upon the culm banks, were added to the daily production. In the following table the shipments (not production) of anthracite are given for 1890, 1900, 1911, 1912, and 1913, exclusive of the washery product obtained from the old culm banks:

Shipments of anthracite, excluding washery and dredge product, by sizes, 1890, 1900, 1911, 1912, and 1913, in long tons.

Year.	Sizes above pea.		Pea and smaller.		Total shipments.
	Quantity.	Percentage.	Quantity.	Percentage.	
1890	28,154,678	76.98	8,419,181	23.02	36,573,859
1900	29,162,459	69.4	12,885,676	30.6	42,048,135
1911	41,667,415	62.0	25,585,104	38.0	67,252,519
1912	39,438,732	63.6	22,607,371	36.4	62,046,103
1913	43,781,936	63.3	25,423,610	36.7	69,205,546

In the following table are given the shipments, including the washery product, since 1890, the statement showing the growth in the proportion of small sizes up to 1909 and then the gradual falling off:

Shipments of anthracite, according to sizes, 1890–1913, in long tons.

Year.	Sizes above pea.		Pea and smaller.		Total shipments.
	Quantity.	Percentage.	Quantity.	Percentage.	
1890	28,154,678	76.9	8,460,781	23.1	36,615,459
1891	30,604,566	75.7	9,843,770	24.3	40,448,336
1892	31,868,278	76.0	10,025,042	24.0	41,893,320
1893	32,294,233	74.9	10,795,304	25.1	43,089,537
1894	30,482,203	73.7	10,908,997	26.3	41,391,200
1895	32,469,367	69.9	14,042,110	30.1	46,511,477
1896	30,354,797	70.3	12,822,688	29.7	43,177,485
1897	28,510,370	68.5	13,127,494	31.5	41,637,864
1898	28,198,532	67.3	13,701,219	32.7	41,899,751
1899	31,506,700	66.1	16,158,504	33.9	47,665,204
1900	29,162,459	64.7	15,945,025	35.3	45,107,484
1901	34,412,974	64.2	19,155,627	35.8	53,568,601
1902	19,025,632	61.0	12,175,258	39.0	31,200,890
1903	37,738,510	63.6	21,624,321	36.4	59,362,831
1904	35,636,661	62.0	21,855,861	38.0	57,492,522
1905	37,425,217	60.9	23,984,984	39.1	61,410,201
1906	32,894,124	59.1	22,804,471	40.9	55,698,595
1907	39,332,855	58.6	27,776,538	41.4	67,109,393
1908	38,319,325	59.3	26,345,689	40.7	64,665,014
1909	36,437,762	58.1	[a] 26,250,597	41.9	[a] 62,688,359
1910	38,415,323	58.5	[a] 27,297,438	41.5	[a] 65,712,761
1911	41,728,071	59.2	[a] 28,696,126	40.8	[a] 70,424,197
1912	39,538,583	60.6	[a] 25,662,670	39.4	[a] 65,201,253
1913	[a] 43,934,919	61.6	[a] 27,360,797	38.4	[a] 71,296,716

[a] Exclusive of coal recovered by river dredges.

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To present statistically the comments made on size division and washery production, the following table, showing washery production since 1890, is given:

Shipments of anthracite from washeries and total shipments, 1890–1913, in long tons.

Year.	Shipments from washeries.	Total shipments.	Percentage of washery output to total shipments.
1890	41,600	36,615,459	0.11
1891	85,702	40,448,336	.21
1892	90,495	41,893,320	.22
1893	245,175	43,089,537	.57
1894	634,116	41,391,200	1.53
1895	1,090,800	46,511,477	2.52
1896	895,042	43,177,485	2.07
1897	993,603	41,637,864	2.39
1898	1,099,019	41,899,751	2.62
1899	1,368,275	47,665,204	2.87
1900	2,059,349	45,107,484	4.57
1901	2,567,335	53,568,601	4.79
1902	1,959,466	31,200,890	6.28
1903	3,563,269	59,362,831	6.00
1904	2,800,466	57,492,522	4.87
1905	2,644,045	61,410,201	4.31
1906	3,846,501	55,698,595	6.91
1907	4,301,082	67,109,393	6.41
1908	3,646,250	64,665,014	5.64
1909	3,694,470	62,688,359	5.26
1910	3,296,318	65,712,761	5.02
1911	3,171,678	70,424,197	4.50
1912	3,155,150	65,201,253	4.84
1913	2,090,170	71,295,716	2.93

The figures showing the washery product are not absolutely exact, for the reason that a few washeries are operated at the mines, the small sizes of the freshly mined coal being washed to remove the slate, and no separate report of the coal so washed is made by the mining companies. "Washery coal" as here reported is for the most part that which is recovered from the old culm banks.

The following table shows the quantities of the different sizes of freshly mined coal and of washery coal shipped in 1912 and 1913:

Shipments, by sizes, from mines and washeries in 1912 and 1913, in long tons.

Size.	1912		1913	
	From mines.	From washeries.	From mines.	From washeries.
Lump and steamboat	418,601	.....	362,084	630
Broken	3,754,567	.....	3,501,211	2,284
Egg	8,932,305	2,759	8,957,166	20,941
Stove	11,825,975	3,425	13,900,576	21,210
Chestnut	14,507,284	93,667	17,060,899	107,918
Pea	6,999,919	206,272	8,056,919	151,762
Buckwheat:				
No. 1	8,115,124	582,460	9,135,587	368,574
No. 2 and rice	3,903,276	772,426	5,081,314	552,723
No. 3 and barley	3,234,598	1,483,914	2,836,147	852,410
Screenings	354,454	10,227	313,643	11,718
Total	62,046,103	3,155,150	69,205,546	2,090,170

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As shown in the preceding table, the stove and chestnut sizes are in the greatest demand and make up over 40 per cent of the total shipments. They are essentially domestic sizes, and the relatively large proportion they make of the shipments serves as an index to the conditions governing the anthracite trade. Egg coal finds its way principally to the furnaces of residences, and pea coal is used in the same way to some extent, though it is also used for kitchen ranges, and some of it goes with the buckwheat, rice, and barley for use as steam coal. The small sizes come directly into competition with bituminous and sometimes are used mixed with bituminous coal for steam purposes, chiefly in hotels, apartment houses, and office buildings. If egg and chestnut are considered as domestic coals, the shipments of domestic sizes in 1913 aggregated 48,277,391 tons of the 71,295,716 tons of mine coal shipped during the year.

The standard screens used in the preparation of anthracite have the following dimensions:

Standard sizes of anthracite.

Size.	Through—	Over—
Broken or grate	4-inch square	2¾-inch square.
Egg	2¾-inch square	2-inch square.
Stove	2-inch square	1⅝-inch square.
Chestnut	1⅝-inch square	¾-inch square.
Pea	¾-inch square	½-inch square.
Buckwheat No. 1	½-inch square	⅜-inch square.
Buckwheat No. 2 or rice	⅜-inch square	¼-inch square.
Buckwheat No. 3 or barley	¼-inch square	$\frac{1}{16}$-inch round.

In the following table are presented statements showing the quantity of each size shipped from each county in 1912 and 1913, with the percentage that each size bears to the total shipments:

Quantity of each size of anthracite shipped from each county in 1912 and 1913, in long tons, and percentage of total.

1912.

County.	Lump and steamboat.	Broken.	Egg.	Stove.
Carbon	12,465	164,130	253,626	300,390
Columbia	20,593	11,547	145,855	149,906
Dauphin	.....	26,688	38,272	132,250
Lackawanna	17,229	578,994	2,230,739	3,212,447
Luzerne	152,717	1,790,303	3,752,474	4,778,433
Northumberland	11,200	228,907	639,230	962,872
Schuylkill	204,397	924,307	1,764,971	2,140,653
Sullivan	.....	11,298	51,946	72,796
Susquehanna	.....	18,393	57,951	79,653
Total	418,601	3,754,567	8,935,064	11,829,400
Percentage of total	.64	5.76	13.70	18.14

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Quantity of each size of anthracite shipped from each county in 1912 and 1913, in long tons, and percentage of total—Continued.

1912—Continued.

County.	Chestnut.	Pea.	Buckwheat No. 1.	Buckwheat No. 2 and rice.
Carbon	425,749	293,306	309,092	292,090
Columbia	210,383	108,780	151,662	121,616
Dauphin	97,202	54,730	121,890	132,583
Lackawanna	3,785,627	1,842,760	2,012,050	929,564
Luzerne	6,026,189	2,463,387	2,722,603	1,206,348
Northumberland	1,154,954	624,010	947,288	550,698
Schuylkill	2,696,948	1,695,045	2,369,046	1,430,942
Sullivan	103,581	68,050	.....	.....
Susquehanna	100,449	56,171	64,602	25,818
Total	14,601,082	7,206,239	8,698,173	4,691,659
Percentage of total	22.38	11.05	13.33	7.19

County.	Buckwheat No. 3 and barley.	Screenings.	Total.
Carbon	101,447	11,601	2,163,896
Columbia	16,362	.....	936,704
Dauphin	32,320	995	637,370
Lackawanna	a 2,247,148	44,472	16,901,030
Luzerne	b 1,735,888	18,114	24,648,456
Northumberland	101,954	17,478	5,238,591
Schuylkill	416,669	46,879	13,689,857
Sullivan	.....	226,333	534,004
Susquehanna	76,310	.....	479,347
Total	4,728,598	365,872	65,229,255
Percentage of total	7.25	.56	100.00

1913.

County.	Lump and steamboat.	Broken.	Egg.	Stove.	Chestnut.
Carbon	15,358	134,842	298,758	390,827	551,536
Columbia	18,157	51,391	107,372	177,850	196,741
Dauphin	.....	24,582	43,435	135,587	112,358
Lackawanna	12,563	504,002	2,304,933	3,790,759	4,386,779
Luzerne	109,915	1,745,626	3,680,454	5,784,859	7,181,114
Northumberland	30,798	170,648	567,634	1,039,617	1,326,782
Schuylkill	175,923	858,688	1,881,280	2,426,315	3,192,963
Sullivan	.....	13,716	49,315	80,009	103,185
Susquehanna and Wayne	.....	.....	44,926	95,963	117,359
Total	362,714	3,503,495	8,978,107	13,921,786	17,168,817
Percentage of total	.51	4.92	12.59	19.53	24.08

County.	Pea.	Buckwheat No. 1.	Buckwheat No. 2 and rice.	Buckwheat No. 3 and barley.	Screenings.	Total.
Carbon	372,972	359,128	299,760	176,946	.....	2,600,127
Columbia	134,600	141,587	86,146	8,688	.....	922,532
Dauphin	64,665	132,562	113,989	84,463	708	712,349
Lackawanna	2,096,974	2,225,647	1,439,209	1,247,806	13,646	18,022,318
Luzerne	2,912,235	3,100,103	1,733,441	1,435,449	30,737	27,713,933
Northumberland	622,441	976,798	582,045	117,677	13,089	5,447,529
Schuylkill	1,880,397	2,495,723	1,365,335	540,479	42,112	14,859,215
Sullivan	66,110	.....	.....	.....	225,069	537,404
Susquehanna and Wayne	58,287	72,613	14,112	77,049	.....	480,309
Total	8,208,681	9,504,161	5,634,037	3,688,557	325,361	71,295,716
Percentage of total	11.51	13.33	7.90	5.17	.46	100.00

a Includes 423,673 tons of "birdseye," a mixture of buckwheat Nos. 2 and 3.
b Includes 251,597 tons of birdseye.

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Distributed by trade regions the shipments of anthracite in 1912 and 1913 were as follows:

Shipments of anthracite, by regions and sizes, 1912 and 1913, in long tons.

1912.

	Lehigh region.	Schuylkill region.	Wyoming region.	Total.
Lump	38,159	230,351	150,091	418,601
Broken	513,068	1,024,884	2,205,317	3,743,269
Egg	1,220,610	2,308,107	5,354,401	8,883,118
Stove	1,435,541	3,061,408	7,259,655	11,756,604
Chestnut	1,885,646	3,683,667	8,928,057	14,497,370
Pea	1,079,167	2,179,384	3,879,590	7,138,141
Buckwheat No. 1	1,299,714	3,202,299	4,195,571	8,697,584
Buckwheat No. 2	945,597	1,973,126	1,756,979	4,675,702
Buckwheat No. 3	366,372	486,573	3,885,567	4,718,512
Screenings	16,251	64,161	57,936	138,348
Total	8,800,125	18,213,960	37,653,164	64,667,249

1913.

Lump	33,299	222,884	106,531	362,714
Broken	395,795	986,679	2,107,305	3,489,779
Egg	1,262,448	2,264,762	5,401,582	8,928,792
Stove	1,797,062	3,397,668	8,647,047	13,841,777
Chestnut	2,311,631	4,282,944	10,471,057	17,065,632
Pea	1,291,412	2,366,797	4,484,362	8,142,571
Buckwheat No. 1	1,439,307	3,361,591	4,703,263	9,504,161
Buckwheat No. 2	1,044,988	1,912,700	2,676,349	5,634,037
Buckwheat No. 3	592,592	565,451	2,530,514	3,688,557
Screenings	11,487	55,909	32,896	100,292
Total	10,180,021	19,417,385	41,160,906	70,758,312

The figures in the foregoing table differ slightly, although not materially, from the returns made by the railroads to the bureau of anthracite coal statistics at Philadelphia. The shipments from Sullivan County and from dredges are not included in either statement.

The table showing the shipments of anthracite reported by the bureau of anthracite coal statistics has been published annually in this chapter. In this table the initial shipments are credited to the Lehigh region, from which 365 tons were shipped in 1820. Exception to this statement is taken by residents of the Wyoming region, and Mr. William Griffith, of Scranton, Pa., has recently contributed to the Wyoming Historical and Geological Society a paper setting forth the claims of that region to priority in the shipments of anthracite. The first authentic shipment of anthracite was certainly from the Wyoming region, for in 1807 a shipment of 55 tons was made by Abijah Smith & Co. from Plymouth to Columbia. So far as the writer knows, there is no record of further shipments from that region before 1820, but Mr. Griffith, quoting from Mr. George B. Kulp, gives the following table to show the probable annual shipments from 1807 to 1820, inclusive. Mr. Griffith, however, does not fill the gap between 1820 and 1829, when, according to the bureau figures, the regular shipments from the Wyoming region began.

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Shipments of anthracite from Wyoming region (Pennsylvania) from 1807 to 1820, as estimated by George B. Kulp.

	Long tons.		Long tons.		Long tons.
1807	55	1812	500	1817	1,000
1808	150	1813	500	1818	1,000
1809	200	1814	700	1819	1,400
1810	350	1815	1,000	1820	2,500
1811	450	1816	1,000		

The following table gives the yearly shipments of anthracite reported by the bureau of anthracite coal statistics from 1820 to the close of 1913, distributed according to the three trade regions. These shipments include only coal loaded on cars for line or tide points, and do not include any coal sold locally and used at and about the mines, nor do they include the shipments from Sullivan County. According to this table, the first regular shipments of coal from the anthracite region were made in 1820 and consisted of 365 tons (one ton for each day of the year) shipped from the Lehigh region, although in order to be historically accurate, credit should be given to the Wyoming region for the 55 tons shipped from Plymouth to Columbia, Pa., in 1807. The estimates of shipments between 1807 and 1820 contained in the preceding table prepared by Mr. Kulp are not official.

Annual shipments from the Schuylkill, Lehigh, and Wyoming regions in 1807 and from 1820 to 1915, in long tons.

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.
1807					55		55
1820			365				365
1821			1,073				1,073
1822	1,480	39.79	2,240	60.21			3,720
1823	1,128	16.23	5,823	83.77			6,951
1824	1,567	14.10	9,541	85.90			11,108
1825	6,500	18.60	28,393	81.40			34,893
1826	16,767	34.90	31,280	65.10			48,047
1827	31,360	49.44	32,074	50.56			63,434
1828	47,284	61.00	30,232	39.00			77,516
1829	79,973	71.35	25,110	22.40	7,000	6.25	112,083
1830	89,984	51.50	41,750	23.90	43,000	24.60	174,734
1831	81,854	46.29	40,966	23.17	54,000	30.54	176,820
1832	209,271	57.61	70,000	19.27	84,000	23.12	363,271
1833	252,971	51.87	123,001	25.22	111,777	22.91	487,749
1834	226,692	60.19	106,244	28.21	43,700	11.60	376,636
1835	339,508	60.54	131,250	23.41	90,000	16.05	560,758
1836	432,045	63.16	148,211	21.66	103,861	15.18	684,117
1837	530,152	60.98	223,902	25.75	115,387	13.27	869,441
1838	446,875	60.49	213,615	28.92	78,207	10.59	738,697
1839	475,077	58.05	221,025	27.01	122,300	14.94	818,402
1840	490,596	56.75	225,313	26.07	148,470	17.18	864,379
1841	624,466	65.07	143,037	14.90	192,270	20.03	959,773
1842	583,273	52.62	272,540	24.59	252,599	22.79	1,108,412
1843	710,200	56.21	267,793	21.19	285,605	22.60	1,263,598
1844	887,937	54.45	377,002	23.12	365,911	22.43	1,630,850
1845	1,131,724	56.22	429,453	21.33	451,836	22.45	2,013,013
1846	1,308,500	55.82	517,116	22.07	518,389	22.11	2,344,005
1847	1,665,735	57.79	633,507	21.98	583,067	20.23	2,882,309
1848	1,733,721	56.12	670,321	21.70	685,196	22.18	3,089,238
1849	1,728,500	53.30	781,556	24.10	732,910	22.60	3,242,966
1850	1,840,620	54.80	690,456	20.56	827,823	24.64	3,358,899

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Annual shipments from the Schuylkill, Lehigh, and Wyoming regions in 1807 and from 1820 to 1913, in long tons—Continued.

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.
1851	2,328,525	52.34	964,224	21.68	1,156,167	25.98	4,448,916
1852	2,636,835	52.81	1,072,136	21.47	1,284,500	25.72	4,993,471
1853	2,665,110	51.30	1,054,309	20.49	1,475,732	28.41	5,195,151
1854	3,191,670	53.14	1,207,186	20.13	1,603,478	26.73	6,002,334
1855	3,552,943	53.77	1,284,113	19.43	1,771,511	26.80	6,608,567
1856	3,603,029	52.91	1,351,970	19.52	1,972,581	28.47	6,927,580
1857	3,373,797	50.77	1,318,541	19.84	1,952,603	29.39	6,644,941
1858	3,273,245	47.86	1,380,080	20.18	2,186,094	31.96	6,839,369
1859	3,448,708	44.16	1,628,311	20.86	2,731,236	34.98	7,808,255
1860	3,749,632	44.04	1,821,674	21.40	2,941,817	34.56	8,513,123
1861	3,160,747	39.74	1,738,377	21.85	3,055,140	38.41	7,954,264
1862	3,372,583	42.86	1,351,054	17.17	3,145,770	39.97	7,869,407
1863	3,911,683	40.90	1,894,713	19.80	3,759,610	39.30	9,566,006
1864	4,161,970	40.89	2,054,669	20.19	3,960,836	38.92	10,177,475
1865	4,356,959	45.14	2,040,913	21.14	3,264,519	33.72	9,652,391
1866	5,787,902	45.56	2,179,364	17.15	4,736,616	37.29	12,703,882
1867	5,161,671	39.74	2,502,054	19.27	5,325,000	40.99	12,988,725
1868	5,330,737	38.52	2,502,582	18.13	5,968,146	43.25	13,801,465
1869	5,775,138	41.66	1,949,673	14.06	6,141,369	44.28	13,866,180
1870	4,968,157	30.70	3,239,374	20.02	7,974,660	49.28	16,182,191
1871	6,552,772	41.74	2,235,707	14.24	6,911,242	44.02	15,699,721
1872	6,694,890	34.03	3,873,339	19.70	9,101,549	46.27	19,699,778
1873	7,212,601	33.97	3,705,596	17.46	10,309,755	48.57	21,227,952
1874	6,866,877	34.09	3,773,836	18.73	9,504,408	47.18	20,145,121
1875	6,281,712	31.87	2,834,605	14.38	10,596,155	53.75	19,712,472
1876	6,221,934	33.63	3,854,919	20.84	8,424,158	45.53	18,501,011
1877	8,195,042	39.35	4,332,760	20.80	8,300,377	39.85	20,828,179
1878	6,282,226	35.68	3,237,449	18.40	8,085,587	45.92	17,605,262
1879	8,960,829	34.28	4,595,567	17.58	12,586,293	48.14	26,142,689
1880	7,554,742	32.23	4,463,221	19.05	11,419,279	48.72	23,437,242
1881	9,253,958	32.46	5,294,676	18.58	13,951,383	48.96	28,500,017
1882	9,459,288	32.48	5,689,437	19.54	13,971,371	47.98	29,120,096
1883	10,074,726	31.69	6,113,809	19.23	15,604,492	49.08	31,793,027
1884	9,478,314	30.85	5,562,226	18.11	15,677,753	51.04	30,718,293
1885	9,488,426	30.01	5,898,634	18.65	16,236,470	51.34	31,623,530
1886	9,381,407	29.19	5,723,129	17.80	17,031,826	52.82	32,136,362
1887	10,609,028	30.63	4,347,061	12.55	19,684,929	56.82	34,641,018
1888	10,654,116	27.93	5,639,236	14.78	21,852,366	57.29	38,145,718
1889	10,486,185	29.28	6,294,073	17.57	19,036,835	53.15	35,817,093
1890	10,867,822	29.68	6,329,658	17.28	19,417,979	53.04	36,615,459
1891	12,741,258	31.50	6,381,838	15.78	21,325,240	52.72	40,448,336
1892	12,626,784	30.14	6,451,076	15.40	22,815,480	54.46	41,893,340
1893	12,357,444	28.68	6,892,352	15.99	23,839,741	55.33	43,089,537
1894	12,035,005	29.08	6,705,434	16.20	22,650,761	54.72	41,391,200
1895	14,269,932	30.68	7,298,124	15.69	24,943,421	56.63	46,511,477
1896	13,097,571	30.34	6,490,441	15.03	23,589,473	54.63	43,177,485
1897	12,181,061	29.26	6,249,540	15.00	23,207,263	55.74	41,637,864
1898	12,078,875	28.83	6,253,109	14.92	23,567,767	56.25	41,899,751
1899	14,199,009	29.79	6,887,909	14.45	26,578,286	55.76	47,665,204
1900	13,502,732	29.94	6,918,627	15.33	24,686,125	54.73	45,107,484
1901	16,019,591	29.92	7,211,974	13.45	30,337,036	56.63	53,568,601
1902	8,471,391	27.15	3,470,736	11.12	19,258,763	61.73	31,200,890
1903	16,474,790	27.75	7,164,783	12.07	35,723,258	60.18	59,362,831
1904	16,379,293	28.49	7,107,220	12.36	34,006,009	59.15	57,492,522
1905	17,703,099	28.83	7,849,205	12.78	35,857,897	58.39	61,410,201
1906	16,011,285	28.75	7,046,617	12.65	32,640,693	58.60	55,698,595
1907	20,141,288	30.01	8,320,653	12.41	38,638,452	57.58	67,109,393
1908	18,006,464	27.85	7,786,255	12.04	38,872,295	60.11	64,665,014
1909	16,864,147	27.21	7,532,271	12.16	37,573,467	60.63	61,969,885
1910	17,845,020	27.49	8,627,539	13.29	38,433,227	59.22	64,905,786
1911	19,375,369	27.70	9,775,018	13.97	40,803,912	58.33	69,954,299
1912	18,013,406	28.32	8,571,861	13.47	37,025,311	58.21	63,610,578
1913	19,338,870	28.00	9,347,583	13.53	40,388,175	58.47	69,069,628
Total	614,097,380	31.46	301,172,559	15.43	1,036,760,952	53.11	1,952,030,891

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A tabular statement of the several sections of the anthracite fields is given in the following table:

Anthracite coal fields, by field, local district, and trade region.

Coal field or basin.	Local district.	Trade region.
Northern	Carbondale	Wyoming.
	Scranton	
	Pittston	
	Wilkes-Barre	
	Plymouth	
	Kingston	
Eastern middle	Green Mountain	Lehigh.
	Black Creek	
	Hazleton	
	Beaver Meadow	
	Panther Creek	
Southern	East Schuylkill	Schuylkill.
	Western Schuylkill	
	Lorberry	
	Lykens Valley	
Western middle	East Mahanoy	
	West Mahanoy	
	Shamokin	

The anthracite fields are reached by 11 so-called initial railroads as follows:

Philadelphia & Reading Railway.
Lehigh Valley Railroad.
Central Railroad of New Jersey.
Delaware, Lackawanna & Western Railroad.
Delaware & Hudson Co.'s Railroad.
Pennsylvania Railroad.
Erie Railroad.
New York, Ontario & Western Railway.
Delaware, Susquehanna & Schuylkill Railroad (part of Lehigh Valley system).
New York, Susquehanna & Western Railroad (part of Erie system).
Lehigh & New England Railroad.

PENNSYLVANIA BITUMINOUS COAL.

Total production in 1913, 173,781,217 short tons; spot value, $193,039,806.

The output of bituminous coal in Pennsylvania in 1913 again broke the record and established a new maximum, exceeding the previous high figure of 1912 by 11,915,729 short tons, or 7.4 per cent, in quantity and by $23,669,309 in value. The increased production in 1913 was due in part to generally improved trade conditions in 1912, in part to the fact that in the earlier year operations were partly suspended on April 1, pending the adjustment of the wage scale, and in part to the labor troubles in the Kanawha district of West Virginia, which increased the demand for Pennsylvania bituminous coal, particularly in the western part of the State. Operators complained of shortage of labor, chiefly of miners, in the central part of the State, in the Westmoreland gas-coal field, and in the Connellsville coking-coal district. The effect of the labor shortage was accentuated, it is claimed, by the tendency on the part of the miners to work fewer days. The latter appears to be borne out by the fact that although opportunity to work was given for more days in 1913 than in any recent year the average production per miner per day declined.

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Increased production in 1913 was well distributed over the entire bituminous district, only 3 counties out of 26 showing decreases. Westmoreland County led in increased output, with a gain of 2,669,153 tons, and supplanted for first place its neighbor and rival, Fayette County, which since 1908 had been the leading coal-producing county of the State. The two counties, Fayette and Westmoreland, which constitute the Connellsville coking district, had a combined production in 1913 of over 65,850,000 short tons, within 10 per cent of the total production of West Virginia, the second coal-producing State in the Union, and exceeding that of Illinois by about 4,000,000 tons. Cambria County showed the second largest gain in 1913, with an addition of 2,036,248 tons to its production in 1912. Allegheny, Armstrong, Indiana, and Washington counties all showed increases of over 1,000,000 tons, the last by more than 1,600,000 tons.

The average value per ton of Pennsylvania bituminous coal advanced from $1.05 in 1912 to $1.11 in 1913. The average in 1912 was the highest obtained for bituminous coal in Pennsylvania for a period of 30 years, with the exception of the strike years, 1902 and 1903, when, because of a scarcity of all kinds of fuel, prices were abnormally inflated. The advance of 6 cents a ton in 1913 over 1912 put the record of that year within 7 cents of the abnormally high value in 1903. As the leading coal-producing State, Pennsylvania sets a good example in the small tonnage that is won by the powder without being previously undercut or sheared. In 1913 the quantity of coal reported to the Survey as shot off the solid was less than 3 per cent of the total output. The quantity mined by machines was 92,487,438 short tons, or 53.2 per cent of the total, against 82,192,042 tons, or 50.8 per cent of the machine-mined coal, in 1912. The number of machines in use increased from 6,176 in 1912 to 6,301 in 1913, although there was a decrease in the number of one type of machine, the punchers, from 3,660 to 3,341. A notable increase from 439 to 736 was made in the number of short-wall machines, and the long-wall type showed a greater proportionate increase, from 52 to 137. The number of chain-breast machines increased from 2,023 to 2,086. The quantity of coal reported as mined by hand in 1913 was 61,509,942 tons.

The number of men employed in the bituminous-coal mines of Pennsylvania in 1913 was 172,196, and they made the unprecedented high average of 267 days, against 165,144 men for 252 days in 1912. In four counties, two of them the Connellsville coking-coal counties, Fayette and Westmoreland, the average working time exceeded 280 days. The average production per man for the year exceeded any previous record of any State and amounted to 1,009 short tons. The average daily production per man fell off slightly, from 3.89 tons in 1912 to 3.78 tons in 1913.

About 10 per cent of the men employed in the bituminous-coal mines of Pennsylvania were on strike in 1913 and the average time lost by them was 16 days. There was no general strike or suspension.

Only a small part of the bituminous-coal production in Pennsylvania is washed, and practically all of the washed product is used in the manufacture of coke. In 1913 the quantity washed was 6,011,172 short tons, or about 3½ per cent of the total production. It yielded 5,400,444 tons of cleaned coal and 610,728 tons of refuse. The quan-

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tity of washed coal used, as reported by the coke operators, was 5,374,759 short tons.

The fatality record compiled by the Bureau of Mines shows that there was an increase in the number of men killed in the bituminous-coal mines of Pennsylvania from 437 in 1912 to 609 in 1913. The chief cause of the larger number of deaths in 1913 was an explosion of dust at the Cincinnati mine, in Washington County, which occurred in April and resulted in the death of 96 men. This was the only instance of an explosion or other accident in which more than one or two men were killed at one time. As usual, the most prolific cause of accident was falls of roof and coal, which in 1913 claimed 313 victims, or more than one-half the total number. Haulage-way accidents were responsible for 102 deaths, and electric shocks and burns for 23. Altogether, 554 men out of a total of 609 were killed under ground, 7 were killed by falls into shafts, and 48 were killed on the surface. The death rate per thousand was 3.54 in 1913, against 2.65 in 1912 and 3.14 in 1911. The quantity of coal mined for each life lost was 285,355 tons in 1913, against 370,402 tons in 1912 and 273,637 tons in 1911.

The statistics of production, by counties, with the distribution of the product for consumption in 1912 and 1913, are shown in the following table:

Bituminous-coal production of Pennsylvania in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Allegheny	18,087,903	474,116	305,096	150	18,867,265	$20,528,181	$1.09	249	20,756
Armstrong	3,849,829	126,031	127,329	1,800	4,104,989	4,054,301	.99	216	5,589
Beaver	160,937	82,912	3,616	.....	247,465	309,304	1.25	261	392
Bedford	503,985	9,511	16,750	201,231	731,477	795,031	1.09	233	1,067
Blair	274,795	366	8,666	40,509	324,336	378,511	1.17	209	467
Butler	969,075	11,284	20,588	.....	1,000,947	1,131,503	1.13	266	1,285
Cambria	14,563,434	1,314,170	407,268	1,300,258	17,585,130	19,200,298	1.09	241	21,356
Center	1,275,221	13,412	2,741	.....	1,291,374	1,292,301	1.00	236	1,788
Clarion	1,158,837	13,249	27,236	.....	1,199,322	1,223,537	1.02	229	1,629
Clearfield	7,149,021	220,326	234,867	334,123	7,938,337	8,230,763	1.04	233	10,372
Clinton	332,974	11,005	1,475	.....	345,454	427,192	1.24	248	398
Elk	1,099,827	11,915	25,344	9,410	1,146,496	1,132,363	.99	245	1,727
Fayette	7,233,920	317,476	588,535	24,226,636	32,366,567	32,595,749	1.01	275	22,776
Huntingdon	811,586	6,087	16,126	1,115	834,914	1,025,646	1.23	254	1,112
Indiana	8,394,140	88,560	317,843	424,384	9,174,927	8,872,019	.97	259	10,992
Jefferson	4,367,620	59,750	109,723	879,443	5,416,536	5,168,998	.95	244	5,940
Lawrence	59,906	3,578	12,339	.....	75,823	94,124	1.24	256	127
Mercer	751,772	51,111	43,345	.....	846,228	1,052,367	1.24	249	1,284
Somerset	9,549,469	112,170	226,505	.....	9,888,144	11,034,445	1.12	257	9,586
Tioga	956,170	29,967	11,650	.....	997,787	1,569,289	1.57	218	1,865
Washington	14,972,227	122,573	367,339	1,182,988	16,645,127	18,012,167	1.08	236	18,714
Westmoreland	19,899,766	659,743	770,489	9,259,551	30,589,549	30,971,778	1.01	272	25,693
Other counties [a] and small mines.	55,294	161,583	12,497	17,920	247,294	270,630	1.09	220	234
Total	116,477,708	3,850,896	3,657,367	37,879,518	161,865,488	169,370,497	1.05	252	165,144

[a] Cameron, Fulton, Greene, Lycoming, and McKean.

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Bituminous-coal production of Pennsylvania in 1912 and 1913, by counties, in short tons—Continued.

1913.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Allegheny	19,014,187	786,049	315,166	2,421	20,117,823	$23,158,897	$1.15	252	21,650
Armstrong	5,068,536	102,739	150,347	.....	5,321,622	5,476,228	1.03	260	6,134
Beaver	170,782	74,149	3,654	.....	248,585	337,372	1.36	282	355
Bedford	589,949	139,988	15,146	105,709	850,792	927,379	1.09	244	1,154
Blair	323,030	317	9,354	59,016	391,717	463,225	1.18	217	553
Butler	1,033,292	17,578	29,132	.....	1,080,002	1,210,524	1.12	263	1,368
Cambria	16,761,239	1,177,991	387,358	1,294,790	19,621,378	21,903,291	1.12	272	21,976
Center	1,475,751	17,271	4,249	.....	1,497,271	1,499,395	1.00	260	1,833
Clarion	1,390,163	4,395	33,290	.....	1,427,848	1,517,316	1.06	252	1,877
Clearfield	7,435,828	234,358	228,701	379,128	8,278,015	8,579,446	1.04	258	10,121
Clinton	330,028	11,578	1,448	.....	343,054	441,249	1.29	281	290
Elk	1,140,364	30,455	30,246	.....	1,201,065	1,251,090	1.04	270	1,721
Fayette	7,727,676	339,125	661,835	23,879,327	32,607,963	37,810,508	1.16	284	23,704
Greene	248,152	6,227	18,423	43,950	316,752	321,001	1.01	207	428
Huntingdon	882,040	5,936	16,761	31,037	935,774	1,060,367	1.13	268	1,262
Indiana	9,638,385	59,051	251,872	255,376	10,204,684	10,297,482	1.01	277	12,026
Jefferson	4,563,844	70,956	120,981	1,046,083	5,801,864	5,794,490	.99	271	5,790
Lawrence	78,478	2,701	13,104	.....	94,283	118,835	1.26	259	220
Mercer	687,869	41,875	47,857	.....	777,601	960,624	1.24	260	1,231
Somerset	9,601,406	77,348	250,022	.....	9,928,776	11,119,355	1.12	270	9,666
Tioga	903,161	31,240	9,347	.....	943,748	1,544,537	1.64	224	1,757
Washington	16,607,903	134,102	424,734	1,142,578	18,309,317	20,497,946	1.12	249	20,012
Westmoreland	22,240,531	598,925	780,723	9,638,523	33,258,702	36,490,802	1.10	281	26,847
Other counties [a] and small mines	45,810	158,076	2,779	15,916	222,581	258,447	1.16	201	221
Total	127,958,404	4,122,430	3,806,529	37,893,854	173,781,217	193,039,806	1.11	267	172,196

[a] Cameron, Lycoming, and McKean.

The statistics of production, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912, are shown in the following table:

Bituminous-coal production of Pennsylvania, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase (+) or decrease (−), 1913.
Allegheny	16,087,010	18,835,336	17,863,795	18,867,265	20,117,823	+ 1,250,558
Armstrong	2,787,508	3,304,915	3,799,227	4,104,989	5,321,622	+ 1,216,633
Beaver	224,450	228,226	203,556	247,465	248,585	+ 1,120
Bedford	435,129	716,833	528,170	731,477	850,792	+ 119,315
Blair	410,161	380,870	294,048	324,336	391,717	+ 67,381
Butler	828,043	1,017,809	957,074	1,000,947	1,080,002	+ 79,055
Cambria	15,545,185	16,629,461	16,928,628	17,585,130	19,621,378	+ 2,036,248
Center	1,239,049	1,293,622	1,140,263	1,291,374	1,497,271	+ 205,897
Clarion	941,059	1,156,697	1,057,390	1,199,322	1,427,848	+ 228,526
Clearfield	7,573,322	8,463,910	7,852,426	7,938,337	8,278,015	+ 339,678
Clinton	272,184	310,973	314,643	345,454	343,054	− 2,400
Elk	1,150,675	1,202,323	1,223,856	1,146,496	1,201,065	+ 54,569
Fayette	28,866,229	31,097,233	26,610,162	32,366,567	32,607,963	+ 241,396
Greene	137,448	77,321	31,743	35,839	316,752	+ 280,913
Huntingdon	502,823	669,226	806,199	834,914	935,774	+ 100,860
Indiana	7,681,205	8,954,366	8,780,983	9,174,927	10,204,684	+ 1,029,757
Jefferson	4,934,907	5,668,883	5,550,816	5,416,536	5,801,864	+ 385,328
Lawrence	156,749	95,102	90,151	75,823	94,283	+ 18,460
Lycoming	28,016	25,725	13,271	7,777	26,953	+ 19,176
Mercer	893,880	867,754	859,355	846,228	777,601	− 68,627
Somerset	7,902,338	8,837,682	9,177,421	9,888,144	9,928,776	+ 40,632
Tioga	785,922	1,037,417	830,330	997,787	943,748	− 54,039
Washington	12,982,179	16,638,677	15,343,772	16,645,127	18,309,317	+ 1,664,190
Westmoreland	25,432,320	22,885,404	24,102,195	30,589,549	33,258,702	+ 2,669,153
Small mines	[a] 169,000	[a] 125,761	[b] 201,783	[c] 203,678	[d] 195,628	− 8,050
Total	137,966,791	150,521,526	144,561,257	161,865,488	173,781,217	+ 11,915,729
Total value	$130,085,237	$153,029,510	$146,154,952	$169,370,497	$193,039,806	+$23,669,309

[a] Includes production of Bradford and Cameron counties.
[b] Includes production of Bradford, Cameron, and McKean counties.
[c] Includes Cameron, Fulton, and McKean counties.
[d] Includes Cameron and McKean counties.

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The bituminous fields of Pennsylvania underlie the greater part of the western half of the State and comprise a total area of about 14,200 square miles. Coal is, or has been mined in about 30 different counties, but the principal mining activities are confined to 10 counties, which contribute about 95 per cent of the total output of the State and about one-third the total production of the United States. The larger developments may be divided into three principal mining districts: (1) The Pittsburgh, embracing Allegheny and Washington counties, in which the Pittsburgh bed furnishes the most of the steam and gas coals for which the district is celebrated; (2) the Connellsville (including the Lower Connellsville, or Klondike), lying in Fayette and Westmoreland counties, in which district the Pittsburgh bed yields the renowned Connellsville coking coal, of which in the two counties alone nearly 66,000,000 short tons, or approximately 14 per cent of the country's total, were produced in 1913; (3) the Cambria-Clearfield, including the areas in Cambria, Clearfield, Indiana, and Jefferson counties, where the production is cheifly from the Lower Freeport "D" bed, which has a fine development in these counties, but which is worthless over most of the rest of the State. Geologically, the principal bituminous-producing formations are the Allegheny and the Monongahela, formerly known as the "Lower" and the "Upper Productive Coal Measures." The Allegheny has at least seven beds, all of which are workable at some point. They are the Brookville, Clarion, Lower, Middle, and Upper Kittanning, and Lower and Upper Freeport. The Lower Kittanning and the two Freeport beds are the principal producers. The Monongahela formation contains, in addition to the Pittsburgh, four other beds, the Redstone, Sewickley, Uniontown, and Waynesburg, all of which are workable locally. The Pittsburgh bed, on account of its nearly uniform thickness over enormous territory (several thousand square miles), its high grade, its adaptability to the production of coke and gas, and its use as a steam fuel, is the most famous coal bed in America and is probably unequaled in the world.

The statistics of the early production of bituminous coal in Pennsylvania, particularly as compared with the anthracite records, are sadly wanting. The United States Census of 1840 showed a production of bituminous coal in the State which amounted to 464,826 short tons. The census of 1860 showed a production of 2,690,786 short tons; that of 1870 showed a production of 7,798,518 short tons. The production for the intervening years, as shown in the table following, has been estimated from the best information obtainable. Since 1871 the records are official.

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Production of bituminous coal in Pennsylvania from 1840 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	464,826	1859	2,400,000	1878	15,120,000	1897	54,417,974
1841	475,000	1860	2,690,786	1879	16,240,000	1898	65,165,133
1842	500,000	1861	3,200,000	1880	18,425,163	1899	74,150,175
1843	650,000	1862	4,000,000	1881	22,400,000	1900	79,842,326
1844	675,000	1863	5,000,000	1882	24,640,000	1901	82,306,946
1845	700,000	1864	5,839,000	1883	26,880,000	1902	98,574,367
1846	760,000	1865	6,350,000	1884	28,000,000	1903	103,117,178
1847	399,840	1866	6,800,000	1885	26,000,000	1904	97,938,287
1848	500,000	1867	7,300,000	1886	27,094,501	1905	118,413,637
1849	750,000	1868	7,500,000	1887	31,516,856	1906	129,293,206
1850	1,000,000	1869	6,750,000	1888	33,796,727	1907	150,143,177
1851	1,200,000	1870	7,798,518	1889	36,174,089	1908	117,179,527
1852	1,400,000	1871	9,040,565	1890	42,302,173	1909	137,966,791
1853	1,500,000	1872	11,695,040	1891	42,788,490	1910	150,521,526
1854	1,650,000	1873	13,098,829	1892	46,694,576	1911	144,561,257
1855	1,780,000	1874	12,320,000	1893	44,070,724	1912	161,865,488
1856	1,850,000	1875	11,760,000	1894	39,912,463	1913	173,781,217
1857	2,000,000	1876	12,880,000	1895	50,217,228		
1858	2,200,000	1877	14,000,000	1896	49,557,453	Total	2,731,945,059

TENNESSEE.

Total production in 1913, 6,903,784 short tons; spot value, $7,883,714.

More satisfactory labor conditions, better transportation facilities, and an improvement in market conditions were evident in the coal trade of Tennessee in 1913, and the effect of these three influences is exhibited in an increased production of 430,556 short tons, or 6.65 per cent, in quantity, and of $503,811, or 6.83 per cent, in value, as compared with 1912, when the output amounted to 6,473,228 tons, valued at $7,379,903. In neither 1912 nor 1913, however, did the production reach as high a figure as in 1910, when the maximum of 7,121,380 tons was obtained. On the other hand, in both of the later years the average value per ton was higher than in 1910, and in 1913, although the quantity of coal produced was 220,000 tons less than in 1910, the value was within $42,000 of the earlier year.

The principal market for steam coal from the Tennessee mines is with the transportation interests, and most of the railroads traversing the southeastern States buy some of their coal from the Tennessee mines. The railroad purchases in 1913 were somewhat larger than in 1912, and one of the important systems which for several years had been buying its supply from another source again became a buyer of Tennessee coal. Prices on railroad contracts made in 1913 were reported as from 2½ to 5 per cent higher than those made in 1912, but they do not seem to have affected the general average, as the gain in value in 1913 over 1912 was only a fraction of 1 per cent, when compared with the gain in output, and the advance in the average value per ton was only a small fraction of 1 cent.

The coal mines of Tennessee were not entirely free from labor troubles in 1913, as there were 857 men on strike during the year, with an average of 50 days each of lost time. As the total time lost was, however, less than 2 per cent of the time worked, there was no appreciable effect upon the production. The total number of men employed in 1913 was 11,263 and the average working time made by each man was 241 days, as compared with 10,309 men for an average of 234 days in 1912, when the time lost by strikes was about half what

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it was in 1913. The average production per man in 1913 was 613 tons for the year and 2.54 tons for each working day, against 628 and 2.68 tons, respectively, in 1912.

Something over one-third of the total coal production of Tennessee was shot off the solid. In 1913 this item amounted to 2,555,482 tons, or 37 per cent of the total; the quantity mined by machines was 1,842,658 tons, or 26.7 per cent of the total; and the hand-mined coal amounted to 2,464,970 tons, or 35.7 per cent. The mines, most of them small ones, which did not report the method of mining, had a total production of 40,674 tons. In 1912 the "powder-mined" product amounted to 2,127,917 tons, or 33 per cent of the total, and the machine-mined product to 1,201,895 tons, or 18.6 per cent, both of these items showing increases in 1913 in quantity as well as percentage of the total, and the hand-mined product was less in both respects. The number of machines in use increased from 227 in 1912 to 252 in 1913. The latter included 176 punchers, 21 chain-breast, 4 long-wall, 50 short-wall or continuous cutters, and 1 radialaxe.

The quantity of coal washed in 1913 was 707,773 tons, which yielded 624,426 tons of cleaned coal and 83,347 tons of refuse. Most of the coal washed is slack used in the manufacture of coke.

The coal-mining fatalities in Tennessee in 1913 numbered 35, an increase of nearly 100 per cent over 1912, when 18 men were killed. In neither year was there an explosion of dust or gas. Falls of roof and coal claimed 25 victims in 1913, and 6 deaths were due to haulage-way accidents. No other one cause was responsible for more than one death. The mortality rate per thousand was 3.1 and the quantity of coal mined for each life lost was 197,251 tons.

The statistics of production, by counties, during 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

Coal production of Tennessee in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Anderson	523,358	7,060	12,049	.....	542,467	$565,782	$1.04	208	798
Campbell	1,706,104	17,511	40,303	.....	1,763,918	2,208,877	1.25	226	2,934
Claiborne	1,226,335	3,529	21,786	.....	1,251,650	1,264,231	1.01	226	1,565
Grundy	249,776	2,691	652	37,470	290,589	314,629	1.08	238	256
Hamilton	310,332	15,122	12,497	57,392	395,843	453,778	1.15	242	607
Marion	621,665	5,129	9,397	14,839	651,030	807,839	1.24	264	924
Morgan	342,053	2,718	8,789	73,696	427,256	425,273	1.00	264	1,035
Overton	55,714	615	1,143	.....	57,472	62,125	1.08	195	122
Rhea	21,998	4,223	7,129	102,334	135,684	159,677	1.18	246	194
Scott	124,324	16,812	3,495	.....	145,131	174,293	1.20	244	415
Other counties[a]	620,120	8,541	20,142	161,682	810,485	939,840	1.16	229	1,399
Small mines	.....	1,703	.....	.....	1,703	3,559	2.09	.....	.....
Total	5,802,779	85,654	137,382	447,413	6,473,228	7,379,903	1.14	234	10,309

[a] Bledsoe, Cumberland, Fentress, Roane, Sequatchie, and White.

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Coal production of Tennessee in 1912 and 1913, by counties, in short tons—Continued.

1913.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Anderson	641,363	5,864	12,118	.....	659,345	$719,196	$1.09	235	913
Campbell	1,713,092	18,394	47,852	.....	1,779,338	2,227,378	1.25	294	3,169
Claiborne	1,422,536	9,500	24,432	.....	1,456,468	1,492,273	1.02	256	1,686
Grundy	263,796	5,084	1,751	49,105	319,736	344,209	1.08	273	495
Hamilton	238,398	6,077	14,623	107,447	366,545	432,971	1.18	225	704
Marion	640,673	6,652	5,853	24,327	677,505	853,570	1.26	263	1,029
Morgan	410,329	3,013	12,127	72,015	497,484	497,794	1.00	266	1,185
Overton	128,486	402	877	.....	129,765	134,068	1.03	219	140
Scott	132,473	10,310	3,300	.....	146,083	183,811	1.26	222	336
Other counties[b]	534,675	9,864	37,247	286,093	867,879	992,234	1.14	233	1,606
Small mines	.....	3,636	.....	.....	3,636	6,210	1.71	.....	.....
Total	6,125,821	78,796	160,180	538,987	6,903,784	7,883,714	1.14	241	11,263

[b] Bledsoe, Cumberland, Fentress, Rhea, Roane, Sequatchie, and White.

The statistics of production, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912, are shown in the following table:

Coal production of Tennessee, 1909–1913, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Anderson	822,803	808,214	735,135	542,467	659,345	+ 116,878
Campbell	1,631,339	1,706,537	1,703,666	1,763,918	1,779,338	+ 15,420
Claiborne	1,320,290	1,495,814	1,287,708	1,251,650	1,456,468	+ 204,818
Cumberland	67,606	49,982	28,852	36,165	3,588	− 32,577
Grundy	422,898	354,398	264,040	290,589	319,736	+ 29,147
Hamilton	217,080	327,392	365,131	395,843	366,545	− 29,298
Marion	480,067	564,667	517,116	651,030	677,505	+ 26,475
Morgan	469,537	482,313	458,097	427,256	497,484	+ 70,228
Overton	50,864	74,035	75,609	57,472	129,765	+ 72,293
Rhea	104,128	156,296	147,599	135,684	109,413	− 26,271
Roane	188,016	193,918	180,293	176,360	162,732	− 13,628
Scott	127,376	359,374	128,728	145,131	146,083	+ 952
White	316,510	346,206	324,339	364,112	347,878	− 16,234
Other counties and small mines	140,131	203,234	216,783	235,551	247,904	+ 12,353
Total	6,358,645	7,121,380	6,433,156	6,473,228	6,903,784	+ 430,556
Total value	$6,920,564	$7,925,350	$7,209,734	$7,379,903	$7,883,714	+$503,811

The Coal Measures of the Appalachian region cross the eastern part of Tennessee in a comparatively narrow belt (from 50 to 70 miles wide) in a northeast-southwest direction. The total area underlain by coal is about 4,400 square miles, and the greater part of the area contains one or more beds of workable thickness and quality. There are three principal basins: (1) The Wartburg, lying north of Emory River and embracing portions of Scott, Anderson, and Morgan counties; it is continuous northward with the Jellico Basin, lying partly in Tennessee and partly in Kentucky; (2) the Walden, a long and narrow basin extending southwestward from Emory River to the Georgia line, and underlying portions of Rhea, Hamilton, and Marion counties; (3) the Sewanee Basin, also long and narrow, to the west

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of and parallel with the Walden, underlying most of Cumberland County and portions of Bledsoe, Sequatchie, Grundy, and Marion counties. In addition to these the Cumberland Basin of Kentucky extends southward into Claiborne County, Tenn., where it is extensively developed.

All of the coals of Tennessee are bituminous, generally high-grade, and some of them make a good quality of coke. Smithing coal is produced in the southern part of the field.

The United States Census of 1840 states that 558 short tons of coal were produced in Tennessee in that year. It is probable that very little was mined in the State prior to that date. By 1860 the production had increased to 165,300 tons, but after that date development was retarded by the Civil War. Since 1870 the production of Tennessee has increased rather regularly, but not so rapidly as that of Alabama. The annual production of the State since 1840 is shown in the following table:

Coal production of Tennessee from 1840 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1840	558	1859	150,000	1878	375,000	1897	2,888,849
1841	600	1860	165,300	1879	450,000	1898	3,022,896
1842	1,000	1861	150,000	1880	495,131	1899	3,330,659
1843	4,500	1862	140,000	1881	840,000	1900	3,509,562
1844	10,000	1863	100,000	1882	850,000	1901	3,633,290
1845	18,000	1864	100,000	1883	1,000,000	1902	4,382,968
1846	25,000	1865	100,000	1884	1,200,000	1903	4,798,004
1847	30,000	1866	100,000	1885	1,440,957	1904	4,732,211
1848	40,000	1867	110,000	1886	1,714,290	1905	5,766,690
1849	52,000	1868	125,000	1887	1,900,000	1906	6,259,275
1850	60,000	1869	130,000	1888	1,967,297	1907	6,810,243
1851	70,000	1870	133,418	1889	1,925,689	1908	6,199,171
1852	75,000	1871	180,000	1890	2,169,585	1909	6,358,645
1853	85,000	1872	224,000	1891	2,413,678	1910	7,121,380
1854	90,000	1873	350,000	1892	2,092,064	1911	6,433,156
1855	100,000	1874	350,000	1893	1,902,258	1912	6,473,228
1856	115,000	1875	360,000	1894	2,180,879	1913	6,903,784
1857	125,000	1876	550,000	1895	2,535,644		
1858	135,000	1877	450,000	1896	2,663,106	Total	123,793,965

TEXAS.

Total production in 1913, 2,429,144 short tons; spot value, $4,288,920.

The coal production of Texas is nearly evenly divided between lignite and bituminous coal, with the balance slightly in favor of the latter. Both showed increases in production in 1913 and both made their record output. The total production in 1913 exceeded that of 1912 by 240,532 short tons, or 11 per cent, in quantity and by $633,176, or 17.3 per cent, in value. Most of the increase in tonnage was from the lignite mines, whose output showed a gain of 190,451 tons—from 990,705 tons in 1912 to 1,181,156 tons in 1913—while the production of bituminous coal increased 50,081 tons—from 1,197,907 tons in 1912 to 1,247,988 tons in 1913. In point of value, however, the advantage was as much in favor of bituminous coal as the gain in quantity was in favor of lignite. The value of lignite increased from $880,788 in 1912 to $1,104,759 in 1913, a gain of $223,971, while the value of the bituminous product increased from $2,774,956 to $3,184,161, a gain of $409,205. The increase in lignite

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tonnage was 3.8 times that of bituminous coal, and the gain in the value of bituminous coal was 1.8 times that of lignite.

The increased production of both bituminous coal and lignite in 1913 is attributed to the labor troubles in Colorado—which reduced the supply of coal from that State coming into western Texas, the continually declining supply of natural gas in the Mid-Continent field, and the decreased supply of fuel oil. In connection with the last item it should be stated that the decreased supply is not due to any falling-off in the production of crude oil, but to the larger output of distillation products, which reduced the residue previously sold as fuel oil.

Both the coal and the lignite mines of Texas were entirely free from labor disturbances in 1913, and in 1912 there were only four instances of idleness from that cause, the longest strike lasting but 10 days.

Notwithstanding the increased production in 1913, there were fewer men employed in the mines of Texas than in either 1911 or 1912, but the average number of days worked increased from 226 in 1911 and 230 in 1912 to 253 in 1913. There were 5,101 men who were reported from the coal mines of the State, as compared with 5,127 in 1912 and 5,353 in 1911. Most of the bituminous mines are operated on the basis of an 8-hour day, and the lignite mines are worked 10 hours daily. The decline in the number of men employed was confined entirely to the lignite fields, there being 1,563 employed in 1913, against 1,609 in 1912, but the average number of days worked increased from 191 in 1912 to 235 in 1913. The number of employees in the bituminous mines increased from 3,518 in 1912 to 3,538 in 1913, and the average number of days worked, from 248 to 261. The average production per man in the bituminous mines of Texas was 353 tons for the year and 1.35 tons for each working day, in 1913, against 340.5 and 1.37 tons, respectively, in 1912. In the lignite mines the average annual production per man in 1913 was 756 tons and 3.22 tons for each working day, against 615.7 tons for the year and the same daily average tonnage, in 1912. The general average production per man was 476 tons per year and 1.88 tons per day in 1913, against 424 and 1.84 tons, respectively, in 1912.

Most of the lignite produced in Texas is mined by hand, and of the bituminous production, nearly one-half is shot off the solid. The use of mining machines has not made much progress in the State, and those that are employed are in the bituminous mines. The production of machine-mined coal in 1913 was slightly less than in 1912, the machine-mined output in 1913 being 100,889 tons as compared with 105,400 tons in 1912. The quantity of coal shot from the solid in 1913 was 612,132 tons, or 25 per cent of the total, and the quantity mined by hand was 1,494,996 tons, or 62 per cent of the total. The number of machines reported for 1913 was 24, of which 20 were punchers, 3 long-wall, and 1 short-wall.

In order to improve the quality of the coal sent to market from the mines at Eagle Pass, washing plants have been installed, and the output is considerably beneficiated thereby. In 1913 the quantity of coal washed was 28,701 tons, which yielded 21,761 tons of cleaned coal and 6,940 tons of refuse, the latter amounting to a little over 30 per cent of the cleaned product. According to statistics collected by the Bureau of Mines, there were 4 fatal accidents in the coal and

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lignite mines of Texas in 1913, all underground, and 3 of them due to falls of roof and coal.

The statistics of production, by counties, in 1912 and 1913, with the distribution of the product for consumption, are shown in the following table. Owing to the fact that there are only one or two mines in each county, the counties producing lignite and bituminous coal, respectively, are combined.

Coal production of Texas in 1912 and 1913, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bituminous: Eastland, Erath, Maverick, Palo Pinto, Webb, Wise, Young	1,153,231	8,688	35,988	1,197,907	$2,774,956	$2.31	248	3,518
Lignite: Bastrop, Fayette, Hopkins, Houston, Lee, Leon, Medina, Milam, Robertson, Titus, Wood	931,023	33,072	26,610	990,705	880,788	.89	191	1,609
Total	2,084,254	41,760	62,598	2,188,612	3,655,744	1.67	230	5,127

1913.

Bituminous: Eastland, Erath, Maverick, Palo Pinto, Webb, Wise, Young	1,214,063	7,700	26,225	1,247,988	$3,184,161	$2.55	261	3,538
Lignite: Bastrop, Fayette, Henderson, Hopkins, Houston, Lee, Leon, Medina, Milam, Robertson, Titus, Wood	1,144,515	4,488	32,153	1,181,156	1,104,759	.94	235	1,563
Total	2,358,578	12,188	58,378	2,429,144	4,288,920	1.77	253	5,101

The coal areas of Texas belong to three of the geologic systems, the Carboniferous, the Cretaceous, and the Tertiary. The Carboniferous coals are found in the north-central part of the State and belong to the southwestern region of the Central Province. The principal mining operations are in Eastland, Palo Pinto, Erath,

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Wise, and Young counties, the mines in the last-mentlned county having been developed only within the last three years. Smaller quantities of coal have been mined in Bowie, Coleman, and McCulloch counties, but none was produced in these counties in 1913. The Cretaceous coals occur in the southern part of the State and are mined chiefly near Eagle Pass, in Maverick County. Although of Cretaceous age, the coals of this district, which extend into Mexico and are mined extensively at El Fenix, near Sabinas, and at Esperanzas, are classed as bituminous coals, and in the southern portions of the field in Mexico make a fair-grade coke. The lignite beds are of enormous extent and occur in a wide belt which stretches from the Sabine on the northeast to the Rio Grande on the southwest. Like the Cretaceous coals, these seem to improve in quality to the southwest, and near Laredo, in Webb County, the lignite is changed to a higher-grade coal, approaching cannel in character and classed as bituminous. The principal lignite operations have been carried on in Anderson, Bastrop, Fayette, Henderson, Hopkins, Houston, Lee, Leon, Medina, Milan, Rains, Robertson, Shelby, Titus, Van Zandt, and Wood counties, but no production was reported from Anderson, Rains, Shelby, and Van Zandt counties in 1913.

The development of the lignite resources of Texas began in the closing decade of the nineteenth century, and except for a temporary setback in 1902 and 1903, following the discovery of petroleum near Beaumont, has progressed steadily with the development and growth in population.

As stated with regard to the utilization of the lignites of North Dakota, lignite is found to be an excellent fuel for the gas producer, and the vast resources of Texas in this regard possess great potentialities for the future.

The first record of the production of bituminous coal in Texas is contained in the volume, Mineral Resources of the United States, 1884. The quantity mined was 125,000 tons. The total production of lignite and bituminous coal in 1913 was almost twenty times the output of 1884, and the 30 years' growth of the coal-mining industry in Texas is exhibited in the following table:

Coal production of Texas from 1884 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1884	125,000	1892	245,690	1900	968,373	1908	1,895,377
1885	100,000	1893	302,206	1901	1,107,953	1909	1,824,440
1886	100,000	1894	420,848	1902	901,912	1910	1,892,176
1887	75,000	1895	484,959	1903	926,759	1911	1,974,593
1888	90,000	1896	544,015	1904	1,195,944	1912	2,188,612
1889	128,216	1897	639,341	1905	1,200,684	1913	2,429,144
1890	184,440	1898	686,734	1906	1,312,873		
1891	172,100	1899	883,832	1907	1,648,069	Total..	26,649,290

UTAH.

Total production in 1913, 3,254,828 short tons; spot value, $5,384,127.

The coal production of Utah in 1912 exceeded for the first time a total of 3,000,000 tons, the output in that year amounting to 3,016,149 short tons, valued at $5,046,451, a gain of more than

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half a million tons and of nearly $800,000 over 1911. Nearly a quarter of a million tons more (238,679) were added in 1913, with an increase in value of $337,676. The percentages of increase were 7.9 in quantity and 6.7 in value, the average value per ton showing a decline from $1.67 to $1.65. In 1912 the industry suffered from a scarcity of labor due to the exodus of foreign miners to the scene of war in the Balkan States. The returns for 1913 indicate a plentiful supply of labor, with an increase of more than 800 employed in the coal mines as compared with the preceding year.

The increased production in 1913 over 1912 appears to have been due principally to activity among the metalliferous mines and the smelting industry, as nearly all of the increased production was in the quantity of coal made into coke, this item alone indicating a gain of 225,461 short tons out of a total increase of 238,679 tons.

Nearly 90 per cent of the total coal production of Utah is mined in Carbon County, which contains a large part of the great Uinta Basin. This county produced in 1913 2,830,102 short tons out of a total for the State of 3,254,828 tons. Its gain in 1913 over 1912 was 145,371 tons. Carbon County is the only one in the State in which coke is made. The combined output of Emery and Grand counties, with a small local production from Sevier County, was 314,915 tons in 1913, a gain of 102,097 tons over 1912.

The efficiency record of the Utah miners shows a considerable falling off in 1913 as compared with other recent years. There were 4,158 men employed in 1913 for an average of 273 days and the average output per man was 783 tons for the year and 2.87 tons for each working day. In 1912, 3,328 men worked an average of 285 days and produced an average per man of 906 tons for the year and 3.18 tons per day. In 1911 the average production was 821 tons and 3.48 tons, respectively. The decreased production per man in 1913 was in spite of a marked increase in the use of machines and in the quantity and percentage of coal mined by them. In 1912 there were only 13 machines in use and the quantity of machine-mined coal was 114,716 tons, or less than 4 per cent of the total. In 1913 there were 50 machines in use and the quantity of coal mined by them was 625,475 tons, or nearly 20 per cent of the total. All but one of the new installations were short-wall machines, the number of this type increasing from 2 to 38. Punchers numbered 5 in both years and chain-breast machines increased from 6 to 7.

The industry was practically free from labor troubles in 1913, only one company reporting idleness from this cause and only 5 men were disaffected. No strikes of any kind were reported in 1912 and only one of 3 days in 1911. Practically all the mines of the State work 8 hours a day.

According to statistics collected by the Bureau of Mines there were 17 fatal accidents in the coal mines of Utah in 1913, a decrease of 1 from 1912. Eleven of the fatalities occurred underground, 1 in a shaft, and 5 on the surface. There were no gas or dust explosions, and all of the deaths occurred singly. Mine cars and locomotives claimed 9 of the 17 victims, 6 underground and 3 on the surface. The death rate per thousand was 4.1, against 5.4 in 1912, and the number of tons mined for each life lost was 191,460, against 167,064.

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The statistics of production, by counties, in 1912 and 1913, with the distribution of the product for consumption, are as follows:

Coal production of Utah in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Carbon	2,232,803	15,536	91,666	344,726	2,684,731	$4,429,857	$1.65	290	2,936
Emery and Grand	201,434	8,021	3,363	.....	212,818	425,547	2.00	278	201
Summit	94,276	2,309	11,272	.....	107,857	164,267	1.52	211	175
Uinta	.....	6,700	100	.....	6,800	17,560	2.58	208	16
Small mines	.....	3,943	.....	.....	3,943	9,220	2.34	.....	.....
Total	2,528,513	36,509	106,401	344,726	3,016,149	5,046,451	1.67	285	3,328

1913.

Carbon	2,134,669	29,442	95,804	570,187	2,830,102	$4,661,865	$1.65	279	3,545
Emery, Grand, and Sevier	300,994	7,774	6,147	.....	314,915	537,083	1.71	253	460
Summit	91,447	2,202	8,893	.....	102,542	166,521	1.62	192	138
Uinta	.....	5,433	52	.....	5,485	14,435	2.63	218	15
Small mines	.....	1,784	.....	.....	1,784	4,223	2.37	.....	.....
Total	2,527,110	46,635	110,896	570,187	3,254,828	5,384,127	1.65	273	4,158

The production by counties during the last five years, with increase and decrease in 1913 as compared with 1912, has been as follows:

Coal production of Utah, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Carbon	2,125,789	2,311,749	2,264,038	2,684,731	2,830,102	+ 145,371
Emery	1,690	40,657	[a] 120,256	[b] 212,818	[c] 314,915	+ 102,097
Morgan, Sanpete	2,000	.....	.....	.....	.....	.....
Summit, Uinta	134,838	163,193	126,228	114,657	108,027	− 6,630
Small mines	2,582	2,210	2,653	3,943	1,784	− 2,159
Total	2,266,899	2,517,809	2,513,175	3,016,149	3,254,828	+ 238,679
Total value	$3,751,810	$4,224,556	$4,248,666	$5,046,451	$5,384,127	+$337,676

[a] Includes Sanpete County. [b] Includes Grand County. [c] Includes Grand and Sevier counties.

The coal fields of Utah are important and widely distributed over the State. The areas known to contain workable beds of coal aggregate about 13,130 square miles, in addition to which there are about 2,000 square miles less known but which may contain workable coal. The largest and commercially the most important coal field in Utah is that of the great Uinta Basin, which lies parallel with and along the southern side of the Uinta Mountains. The field extends from Crested Butte about one-third of the way across Colorado on the east, to the western part of Carbon and Emery counties in Utah on the west. In Utah this basin underlies a large portion of Uinta, Wasatch, and Carbon counties, its southern border being in Grand, Emery, and Sevier counties. The coal-bearing rocks are exposed

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along the northern rim of the basin, but this portion of the area is far removed from transportation and has been little developed. The most important coal field is on the southern rim of the basin in the Book Cliffs of western Colorado and eastern Utah. For this reason the productive area in Utah is generally known as the Book Cliffs field. The principal mining operations are carried on in Carbon County, at Castle Gate, Sunnyside, Clear Creek, Winter Quarters, Black Hawk, Hiawatha, Kenilworth, and Pleasant Valley, more than 85 per cent of the total production of the State (2,830,102 tons in 1913) being from Carbon County. The output of Emery and Grand counties (314,715 tons in 1913) is from the same field, and if this be added to the Carbon County production the percentage of Utah's output from this area is approximately 97 per cent. A large field in the southern part of the State underlies considerable portions of Garfield, Kane, and Iron counties, and a small section in the eastern part of Washington County. This area has not been developed on a commercial scale, as it is not at present reached by any railroad and has been opened only for small local consumption. A small area in Summit County, in the northern part of the State, known as the Weber field, although only a few miles in extent in Utah, has been commercially developed, as it is convenient to the markets of Ogden and Salt Lake City. Summit County's production exceeds 100,000 tons annually, having been 107,857 short tons in 1912 and falling off to 102,542 tons in 1913. There are several other small areas in Sanpete, Sevier, and Wayne counties. An insignificant amount of coal has been mined in Sanpete County, but the other areas are practically untouched.

The Ninth United States Census recorded the first production of coal in Utah with an output of 5,800 tons. Ten years later the production amounted to less than 15,000 tons. It assumed some importance in 1882, when the production amounted to 100,000 tons and reached the million-ton mark in 1900. In 1909 it exceeded 2,000,000 tons.

The annual production since 1870 has been as follows:

Annual production of coal in Utah, 1870–1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1870	5,800	1882	100,000	1894	431,550	1906	1,772,551
1871	.....	1883	200,000	1895	471,836	1907	1,947,607
1872	.....	1884	200,000	1896	418,627	1908	1,846,792
1873	.....	1885	213,120	1897	521,560	1909	2,266,899
1874	.....	1886	200,000	1898	593,709	1910	2,517,809
1875	.....	1887	180,021	1899	786,049	1911	2,513,175
1876	50,400	1888	258,961	1900	1,147,027	1912	3,016,149
1877	50,400	1889	236,651	1901	1,322,614	1913	3,254,828
1878	67,200	1890	318,159	1902	1,574,521		
1879	50,000	1891	371,045	1903	1,661,409	Total	34,252,834
1880	14,748	1892	361,013	1904	1,493,027		
1881	52,000	1893	413,205	1905	1,332,372		

VIRGINIA.

Total production in 1913, 8,828,068 short tons; spot value, $8,952,653.

Virginia exceeded all previous records in 1913 in the quantity of coal produced, and for the first time in six years the value of the output per ton exceeded $1. The chapter added to the history of

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coal mining in Virginia by the record of 1913 is an interesting one. The quantity of coal produced exceeded that of 1912 by 981,430 short tons, or 12.5 per cent, with a gain in value of $1,434,077, or 19.1 per cent; the quantity of coal mined by machines increased a little over a million tons; the average number of working days was exceptionally large; the average production per man reached nearly a thousand tons for the year; the quantity of coal shot off the solid was reduced nearly a million tons, as compared with 1912; the number of fatal accidents was reduced by a little more than two-thirds, and there was not a single strike or lockout reported. This record bears on its face the evidence that the year was exceptionally gratifying to both operators and employees.

As in 1912, the principal increase in 1913 was in Wise County, whose output showed an advance of 603,385 tons, or more than 60 per cent of the total increase. In 1912 Wise County contributed more than 75 per cent of the total increase, and during the last six years there has not been an exception to a steady increase in the production from that county. Russell County, the latest in which coal-mining operations have been developed (having been opened up by the completion in 1908 of the Carolina, Clinchfield & Ohio Railway from Dante, Va., to Spartanburg, S. C.), increased its putput in 1913 more than 200,000 tons over that of the preceding year; and Tazewell County, the oldest of the important producing counties in southwest Virginia, had an increase of 145,308 tons. Lee County showed only a small gain (12,039 tons).

In the reports for 1911 and 1912 mention was made of the unfavorable comparison made by Virginia with the other States of the Appalachian province in the quantity and percentage of coal shot off the solid. A marked improvement in that respect is presented in the present report. In 1912 the powder-mined coal amounted to 3,741,533 short tons, or 47.7 per cent of the total; in 1913 that item was reduced to 2,879,108 tons, or 32.6 per cent of the total. The quantity of machine-mined coal on the other hand increased from 3,205,504 tons, or 40.8 per cent of the total, in 1912, to 4,206,988 tons, or 47.6 per cent of the total, in 1913. The number of machines in in use in 1913 was 187 (against 185 in 1912), of which 106 were chain-breast, 76 were short-wall, 1 was long-wall, and 4 were punchers. The quantity of coal mined by hand was 1,740,485 short tons in 1913, against 898,821 in 1912.

For several years Virginia has stood relatively high in the quantity of coal produced by each man employed, and 1913 was no exception to the rule. The number of men employed in the coal mines of the State increased from 8,678 in 1912 to 9,162 in 1913, and the average working time from 251 days to 280. The average production per man in 1912 was 904 tons, and in 1913 it was 964 tons. The average daily production per man was slightly less in 1913, being 3.44 tons against 3.6 tons in 1912.

The most gratifying part of the record of 1913 was in the reduction of the number of fatal accidents, as shown by the report of the bureau of mines. In 1912 there were 75 men killed in the coal mines of Virginia and the death rate per thousand was 8.6—unfortunately high; in 1913 there were 24 fatalities and the death rate per thousand was 2.6. The quantity of coal mined for each life lost in 1913 was 367,836 tons against 104,622 tons in 1912.

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The statistics of production, by counties, in 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

Coal production of Virginia in 1912 and 1913, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Lee	718,570	5,245	15,725	11,736	751,276	$875,092	$1.16	269	1,081
Tazewell	1,057,788	26,369	36,805	181,081	1,302,043	1,318,762	1.01	203	1,367
Wise	3,008,443	65,277	90,872	1,335,582	4,500,174	4,094,905	.91	261	4,451
Other counties [a] and small mines	1,242,911	10,766	39,468	.....	1,293,145	1,229,317	.95	252	1,779
Total	6,027,712	107,657	182,870	1,528,399	7,846,638	7,518,576	.96	251	8,678

1913.

Lee	704,941	7,509	20,637	30,228	763,315	$874,674	$1.15	263	1,023
Tazewell	1,207,487	22,938	31,966	184,960	1,447,351	1,610,548	1.11	236	1,460
Wise	3,236,005	35,260	94,119	1,738,175	5,103,559	4,899,390	.96	291	4,933
Other counties [a] and small mines	1,467,048	17,725	29,070	.....	1,513,843	1,568,041	1.04	296	1,746
Total	6,615,481	83,432	175,792	1,953,363	8,828,068	8,952,653	1.01	280	9,162

[a] Henrico, Montgomery, Pulaski, and Russell.

The statistics of production, by counties, for the last five years, with increase and decrease in 1913 as compared with 1912, are shown in the following table:

Coal production of Virginia, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Lee	.....	797,096	720,695	751,276	763,315	+ 12,039
Tazewell	975,665	1,187,146	1,281,224	1,302,043	1,447,351	+ 145,308
Wise	2,841,448	3,730,992	3,754,360	4,500,174	5,103,559	+ 603,385
Russell	[a] 931,276	[b] 790,066	[b] 1,107,056	[b] 1,292,365	[b] 1,512,356	+ 219,991
Small mines	3,828	2,697	1,332	780	1,487	+ 707
Total	4,752,217	6,507,997	6,864,667	7,846,638	8,828,068	+ 981,430
Total value	$4,251,056	$5,877,486	$6,254,804	$7,518,576	$8,952,653	+$1,434,077

[a] Includes Lee, Montgomery, and Pulaski counties.
[b] Includes Henrico, Montgomery, and Pulaski counties.

The coal areas of Virginia which have produced or are producing coal belong to (1) the Atlantic coast region, which includes the Richmond Basin covering portions of Henrico, Chesterfield, Powhatan, Goochland, and Amelia counties, and a small area in Prince Edward, Cumberland, and Buckingham counties; (2) the Appalachian region which includes a number of separate areas extending across the western part of the State from Frederick County on the north to the Tennessee line on the south. The Richmond Basin is the only area of free-burning coal located immediately adjacent to the Atlantic seaboard. The first coal mined in the United States was from this area, mines having been opened and worked as early as 1750. The coal areas of the Appalachian region in Virginia include a portion of the Pocahontas or Flat Top, and the Big Stone Gap or Clinch Valley, fields of Tazewell, Russell, Wise, Lee, Scott, Dickenson, and Buchanan counties. It also embraces small scattered areas in Freder-

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ick, Augusta, Botetourt, Bland, and Wythe counties, which are nonproductive at present, and two areas in Montgomery and Pulaski counties. Coal mining in the last two counties was carried on to a limited extent prior to the Civil War. During the period that the zinc smelter at Bertha was in operation (the smelter was abandoned in 1911) the coal mines of Pulaski County were worked by the smelter company for its own fuel. The production at the present time amounts to between 25,000 and 40,000 tons a year. The Montgomery County production is for relatively local consumption, though a considerable amount of development work has been done by the Virginia Anthracite Coal Co.

Coal mining on an extensive scale in southwestern Virginia began with the completion of the New River division of the Norfolk & Western Railway in 1883, which opened the Pocahontas coal field. Ten years later the completion of the Clinch Valley branch of the same line permitted the development of the Wise County coal field. There were no other new developments in Virginia until 1905 when with the construction of the Virginia & Southwestern Railway from Bristol to Pennington Gap and Appalachia the Black Mountain district of Lee County was made available. The first shipments were made from this district in 1907. Lee County is now producing at the rate of 750,000 tons a year. The latest field to be developed is in Russell County, opened by the completion in 1908 of the Carolina, Clinchfield & Ohio Railway from Dante, Va., to Spartanburg, S. C. Russell County's production has increased from about 220,000 tons in 1908 to nearly 1,500,000 tons in 1913.

During the last four years new life has been introduced into the Richmond Basin areas by the reopening of the old Gayton mines in Henrico County. For many years after the opening of the southwest Virginia and the southern West Virginia coals the mines of the Richmond Basin lay idle or were worked only for a restricted local market. A considerable tonnage was reported for each of the last two years.

The annual production of Virginia from 1822 to the close of 1913 is shown in the following table:

Production of coal in Virginia from 1822 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1822	54,000	1846	340,000	1870	61,803	1894	1,229,083
1823	60,000	1847	325,000	1871	70,000	1895	1,368,324
1824	67,040	1848	318,000	1872	69,440	1896	1,254,723
1825	75,000	1849	315,000	1873	67,200	1897	1,528,302
1826	88,720	1850	310,000	1874	70,000	1898	1,815,274
1827	94,000	1851	310,000	1875	60,000	1899	2,106,791
1828	100,080	1852	325,000	1876	55,000	1900	2,393,754
1829	100,000	1853	350,000	1877	50,000	1901	2,725,873
1830	102,800	1854	370,000	1878	50,000	1902	3,182,998
1831	118,000	1855	380,782	1879	45,000	1903	3,451,307
1832	132,000	1856	352,687	1880	43,079	1904	3,410,914
1833	125,000	1857	363,605	1881	50,000	1905	4,275,271
1834	124,000	1858	377,690	1882	112,000	1906	4,254,879
1835	120,000	1859	359,055	1883	252,000	1907	4,710,895
1836	124,000	1860	473,360	1884	336,000	1908	4,259,042
1837	160,000	1861	445,165	1885	567,000	1909	4,752,217
1838	300,000	1862	445,124	1886	684,951	1910	6,507,997
1839	396,000	1863	[a] 40,000	1887	825,263	1911	6,964,667
1840	424,894	1864	40,000	1888	1,073,000	1912	7,846,638
1841	379,600	1865	40,000	1889	865,786	1913	8,828,068
1842	373,640	1866	40,000	1890	784,011		
1843	370,000	1867	50,000	1891	736,399	Total	96,287,781
1844	365,000	1868	59,051	1892	675,205		
1845	350,000	1869	65,000	1893	820,339		

[a] West Virginia separated from Virginia.

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WASHINGTON.

Total production in 1913, 3,877,891 short tons; spot value, $9,243,137.

For the first time in three years the coal production of Washington showed an increase over that of the preceding year. The increase over 1912 was substantial, amounting to 516,959 short tons, or 15.38 per cent, in quantity, with a gain of $1,200,266, or 14.92 per cent, in value. Even this increase, however, did not bring the output up to the record made in 1910, when the maximum product of 3,911,899 tons was mined. It indicates, nevertheless, a recovery from the depressed condition into which coal mining in Washington was forced in 1911 and 1912 by the competition of California petroleum as a railroad and manufacturing fuel. The use of petroleum continues, but the increase in population, improved business conditions, and a strike of several months' duration in the coal mines of British Columbia, furnished a better market for Washington coal in 1913 than was experienced in 1911 and 1912. The slightly lower values in 1913 (the average value per ton declining from $2.39 to $2.38) were due rather to the ability of operators to dispose of some of the less desirable grades than to any actual decline in price. In 1912 the average value per ton was 10 cents higher than in 1911, although demand was light and production decreased over 200,000 tons, the fact being that in 1912 such demand as existed was largely for domestic consumption, which preferred higher grades of screened coal, and left the slack and lower grades a drug on the market. It did not necessarily mean a better return to the operators on the gross production of the mines. Conversely, the slightly lower values in 1913 probably resulted in actually better returns per ton of coal mined than was obtained in 1912. The generally improved tone in the coal-mining business of the State in 1913 is shown by the fact that increased production was made in every county. The largest gain was made in King County, whose output increased 310,589 tons, or nearly 30 per cent, over that of 1912. The quantity of coal made into coke, all from Pierce County, increased from 76,741 tons to 118,698 tons. Most of the coke goes to the smelter at Tacoma.

The number of men employed in the coal mines of Washington increased from 5,519 to 5,794, and the average working time increased from 226 to 260 days. The average production per man was 669 tons for the year, and 2.57 tons for each working day in 1913, compared with 609 tons and 2.69 tons, respectively, in 1912. There were 1,239 men on strike during 1913, with an average lost time of 49 days. The total time lost was about 4 per cent of the total time made.

Of the total production of coal in 1913, 2,120,257 tons, or 55 per cent, were mined by hand; 1,465,248 tons, or 38 per cent, were powder-mined, or shot off the solid, and 280,515 tons, or 7 per cent, were mined by machines, of which 63 were reported in use. All but two of the machines in use were of the radialaxe, or post-puncher type, which is best adapted to the steep inclination of most of the coal beds. The two exceptions consisted of one puncher and one short-wall machine, in the Roslyn field, where the bed lies relatively flat.

Probably a larger percentage of coal is washed in the State of Washington than in any other coal-producing State. In 1913

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1,643,282 tons, or 42 per cent of the total, were washed, yielding 1,343,120 tons of cleaned coal and 300,162 tons of refuse.

Reports to the Bureau of Mines show that there were 22 fatalities among the coal miners of Washington in 1913. Of that number, 21 were underground, and 1 was in a shaft. Seven of the accidents underground were due to falls of roof, 4 to mine cars and locomotives, 5 to gas explosions, and 5 to other causes. The death rate per thousand was 3.8, and there were 176,268 tons of coal mined for each life lost.

The statistics of production, by counties, in 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

Coal production of Washington in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
King	942,296	51,266	69,548	.....	1,063,110	$2,329,397	$2.19	232	1,891
Kittitas	1,182,704	14,541	40,182	.....	1,237,427	3,371,651	2.72	188	1,737
Lewis	113,751	8,646	4,980	.....	128,377	240,541	1.87	178	244
Pierce	660,985	4,712	45,855	76,741	788,293	1,864,838	2.37	275	1,477
Other counties[a]	140,541	1,130	2,064	.....	143,725	236,444	1.65	172	170
Total	3,041,277	80,295	162,619	76,741	3,360,932	8,042,871	2.39	226	5,519

1913.

King	1,278,813	22,659	72,227	.....	1,373,699	$3,198,662	$2.33	277	2,260
Kittitas	1,273,353	16,831	43,971	.....	1,334,155	3,600,900	2.70	228	1,587
Lewis	128,528	16,433	6,485	.....	151,446	266,408	1.76	196	241
Pierce	681,534	6,104	50,089	118,698	856,425	1,919,254	2.24	286	1,499
Other counties[a]	158,326	675	3,165	.....	162,166	257,913	1.59	209	187
Total	3,520,554	62,702	175,937	118,698	3,877,891	9,243,137	2.38	260	5,794

[a] Thurston and Whatcom.

The statistics of production, by counties, during the last five years, with increase in 1913 as compared with 1912, are shown in the following table:

Production of coal in Washington, 1909–1913, in short tons.

County.	1909	1910	1911	1912	1913	Increase, 1913.
King	1,216,012	1,242,340	1,259,521	1,063,110	1,373,699	310,589
Kittitas	1,550,539	1,661,650	1,256,745	1,237,427	1,334,155	96,728
Lewis	121,573	179,484	172,734	128,377	151,446	23,069
Pierce	609,467	786,096	783,196	788,293	856,425	68,132
Other counties	[a] 104,672	42,329	100,619	143,725	162,166	18,441
Total	3,602,263	3,911,899	3,572,815	3,360,932	3,877,891	516,959
Total value	$9,158,999	$9,764,465	$8,174,170	$8,042,871	$9,243,137	$1,200,266

[a] Includes small mines.

The coals of Washington, although limited to six or seven somewhat scattered areas in the western half of the State, chiefly along the eastern border of Puget Sound, have a wide range in character. Lignites occur in the southwestern part of the State in Cowlitz, Lewis, and Thurston counties; and in Lewis County, as the measures approach the mountians, the coal grades into subbituminous and

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bituminous quality. The areas along Puget Sound contain subbituminous and bituminous coals, some of the latter possessing fair coking quality, and in the northwestern part of the State on the slopes of Mount Baker in Whatcom County anthracite has been reported. Some natural coke has been observed. The coking coals of Washington are the only ones of that grade on the Pacific coast. They are found in the Wilkeson-Carbonado district in Pierce County, in the North Puget Sound field in Skagit and Whatcom counties, and in the northern part of the Roslyn field in Kittitas County; but at present coke is made only in the Wilkerson-Carbonado district. This coal is somewhat high in ash and is usually washed before coking. The smelter at Tacoma takes most of the coke. The coal areas are divided into four principal fields known as (1) the North Puget Sound, including the counties of Whatcom and Skagit; (2) the South Puget Sound, containing the operations in King and Pierce counties; (3) the Roslyn field, in Kittitas County; and (4) the Southwestern field, embracing the counties of Cowlitz, Lewis, and Thurston. Two small subbituminous areas, one just east of Everett in Snohomish County, and the other in the northeastern part of King County, are not mined at the present time. The coal-mining industry of Washington has suffered considerably during the last few years from the competition of fuel oil from California, the Puget Sound steamers (the former principal consumers of Washington coal) and the railroads having adopted petroleum for fuel. Even the railroads that have their own coal mines immediately on their lines are using oil for their locomotives, particularly through the forested areas where the sparkless character of that fuel gives protection against fire. The cleanliness of the liquid fuel and its greater economy in labor give it a decided advantage over coal as a steam fuel on the Sound steamers.

The consumption of California oil for fuel in 1913 was approximately 63,000,000 barrels, equivalent to about four and one-half times the total production of coal in the Pacific coast States. It is estimated that the consumption of fuel oil in markets tributary to the coal mines in Washington displaced 5,000,000 tons of coal. The railroads alone used nearly 4,000,000 barrels of oil, equivalent to 1,150,000 tons of coal, or about half of the coal production of the State in 1913.

Coal was first discovered in Washington in 1848, when a lignite of rather low grade was found in the Cowlitz Valley. Four years later bituminous coal was discovered on Bellingham Bay, Whatcom County, and the first mine in the State was opend on this bed. Shipments did not begin, however, until 1860. This mine was operated continuously from 1860 until 1878, when on account of a fire caused by spontaneous combustion the workings were abandoned, and they have not since been reopened. Shipments were not resumed from any of the mines in the northern district until 13 years later in 1891. Coal was discovered in King County in 1859, and mining began near the present Issaquah in 1862. Shipments to San Francisco began in 1871, since which time the Washington mines have been an important source of coal supply to the San Francisco market. About the same time the Talbot and the Renton mines, which are in King County, began shipping, and rail connection between the Renton mines and Seattle was obtained in 1877. Production in the Green River district, also in King County, began between 1880 and 1885; and the Pierce County fields, which had been opened in 1875 and afterwards abandoned, again began shipping about the same time.

The Roslyn mines, on the east side of the Cascade Range, were opened in the first half of the same decade. The Bellingham Bay mines in the first year of their recorded production, 1860, shipped 5,374 tons. Washington's maximum output of coal was 3,911,899 short tons, made in 1910.

The production of coal in Washington since 1860, when the industry in the State began, has amounted to 64,459,440 short tons, as shown in the following table:

Production of coal in Washington, 1860–1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1860	5,374	1874	30,352	1888	1,215,750	1902	2,681,214
1861	6,000	1875	99,568	1889	1,630,578	1903	3,193,273
1862	7,000	1876	110,342	1890	1,263,089	1904	3,137,681
1863	8,000	1877	120,896	1891	1,056,249	1905	2,864,926
1864	10,000	1878	131,660	1892	1,213,427	1906	3,276,184
1865	12,000	1879	142,666	1803	1,264,877	1907	3,680,532
1866	13,000	1880	145,015	1894	1,106,470	1908	3,024,943
1867	14,500	1881	196,000	1895	1,191,410	1909	3,602,263
1868	15,000	1882	177,340	1896	1,195,504	1910	3,911,899
1869	16,200	1883	244,990	1897	1,434,112	1911	3,572,815
1870	17,844	1884	166,936	1898	1,884,571	1912	3,360,932
1871	20,000	1885	380,250	1899	2,029,881	1913	3,877,891
1872	23,000	1886	423,525	1900	2,474,093		
1873	26,000	1887	772,601	1901	2,578,217	Total	64,459,440

WEST VIRGINIA

Total production in 1913, 71,308,982 short tons; spot value, $71,872,165.

With a production in 1913 exceeding for the first time in its history a total of 70,000,000 tons, West Virginia became firmly established the second in rank among the coal-producing States. Compared with 1912, when the output of coal amounted to 66,786,687 short tons, up to that time the record tonnage, the quantity produced in 1913 showed a gain of 4,522,295 short tons, or 6.77 per cent. The increased production was accompanied by a considerably larger gain in value, which showed an increase over 1912 of $9,079,931, or 14.46 per cent. The average value per ton for the first time in 10 years and for the fifth time in the last 25 years, exceeded $1. The increased production in 1913 was in spite of the fact that the labor troubles in the Paint Creek and Cabin Creek districts of the Kanawha field which began in the early part of 1912, were not settled until well into the spring of 1913, and unprecedented floods in the Ohio Valley (also in the spring of the year) reduced shipments to the west for a considerable length of time. A few of the mines that were closed by the strike were not reopened during 1913, and the total production from the two districts affected was much below the normal output. The deficiency from these districts, however, was more than offset by the gains in other districts, and Kanawha County itself, in which the affected districts are located, showed an increase in 1913 over 1912 of nearly 260,000 tons. The increased production was well distributed over the State, there being but 3 counties out of 30 whose output is published, in which decreases were shown. These 3 counties were relatively small producers and the total decrease was less than 70,000 tons. The principal increases were made in McDowell County, 689,158 tons; Raleigh County, 563,364 tons, Logan County, 556,772 tons; and Harrison County, 412,665 tons, all but Harrison County being in the southern part of the State.

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Of the total increase of over 4,500,000 tons, the quantity of coal made into coke in 1913 made up only 75,585 tons, indicating that coke manufacture in the State fell relatively behind. This does not mean, however, that less coke is being made from West Virginia coal. Large quantities of West Virginia coal are made into coke in ovens (principally of the retort type) located outside the State, and in 1913 the coal shipped from West Virginia mines for coking at distant ovens was about twice as much as that used for the same purpose in the State.

Notwithstanding the increased production and improved prices in 1913, the year was not a satisfactory one to the operators, and the situation has been described as feverish. The labor difficulties were followed by an investigation by a committee from the United States Senate, and when the legislature met in January nearly 50 bills (most of which the operators considered prejudicial to the industry) were introduced and some of them became laws. One of the bills, not in itself of the prejudicial class, was a workman's compensation bill, enacted in February, which provided that 1 per cent of the pay rolls should be paid into the compensation fund, 90 per cent by the employers and 10 per cent by the employees. During the year an amendment to the constitution of the State was adopted, which provides for the prohibition of the manufacture and sale of intoxicating liquors after July 1, 1914. This is expected to result in the exodus of some of the miners, but the operators are hopeful of replacing the deserters with a better class of labor, and it is believed that the improved accident record of 1913 will be continued with even better results after the State-wide prohibition goes into effect.

According to the Bureau of Mines, the number of fatal accidents in the coal mines of West Virginia showed a decrease of 22, from 359 in 1912 to 337 in 1913, although there was an increase of nearly 10 per cent in the number of men employed. There was no explosion of gas or dust in 1913, and 60 per cent of the fatalities, or 200 altogether, were caused by falls of roof or coal. Mine cars and locomotives killed 86; electric shocks and burns, 17, and explosions of powder, 8. Altogether 319 of the accidents occurred underground, 2 in shafts, and 16 on the surface. The death rate per thousand was 4.5 against 5.26 in 1912, and the quantity of coal mined for each life lost was 211,599 tons, against 186,035 tons in 1912.

Labor was in better supply in 1913 than for some years past, but not equal to the demand. The number of men employed in 1913 was 74,786, compared with 68,248 in 1912, but there was a decrease in the average working time, largely because of the strike, from 266 days to 234 days. The average production per man was 954 tons for the year, and 4.08 tons for each working day. In 1912 the corresponding averages were 979 and 3.68 tons. The gain in daily efficiency was due in no small degree to the increased use of mining machines. The quantity of coal mined by machines increased from 34,946,394 tons in 1912 to 39,410,264 tons, an increase of 4,453,870 tons, or within 60,000 tons of the total increased production. The number of machines in use increased from 2,253 to 2,541. Chain-breast machines constituted more than half of the total number, there being 1,364 of that type employed. Pick machines numbered 562; short-wall machines, including 7 Hess dustless machines, 365; long-wall machines, 231; and radialaxe or post-punchers, 19.

Labor troubles caused the loss of 377,405 working days, or an average of 43 days for 8,800 men idle. Only a small percentage of

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West Virginia coal is washed before being sold or used. In 1913 the quantity of coal reported as washed was 1,580,819 short tons, which yielded 1,493,903 tons of cleaned coal, and 86,916 tons of refuse.

The statistics of production, by counties, in 1912 and 1913, with the distribution of the product for consumption, are shown in the following table:

Coal production of West Virginia in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Barbour	1,123,533	5,077	23,479	11,272	1,163,361	$845,877	$0.73	221	1,110
Boone	372,830	3,161	3,985	.....	379,976	324,333	.85	210	397
Braxton	229,433	2,540	3,015	.....	234,988	200,085	.85	189	205
Brooke	482,846	9,766	1,859	.....	494,471	549,168	1.11	240	473
Clay	207,023	1,791	3,311	.....	212,125	176,976	.83	209	277
Fayette	8,477,752	144,330	219,650	794,498	9,636,230	9,549,855	.99	227	11,983
Gilmer	69,675	6,060	1,000	.....	76,735	68,887	.90	214	120
Harrison	5,092,440	18,603	53,503	7,226	5,171,772	4,173,029	.81	211	4,322
Kanawha	4,912,806	115,737	85,014	.....	5,113,557	4,957,392	.97	181	7,040
Logan	4,121,966	29,390	45,388	.....	4,196,744	3,779,439	.90	233	3,419
McDowell	13,634,755	216,618	302,588	1,655,328	15,809,289	15,384,767	.97	234	14,401
Marion	5,409,121	46,182	176,423	161,398	5,793,124	4,942,834	.85	258	4,603
Marshall	601,856	181,173	14,999	.....	798,028	800,027	1.00	268	825
Mason	104,734	24,313	2,256	.....	131,303	128,314	.98	134	327
Mercer	2,654,704	34,446	49,707	370,714	3,109,571	2,961,587	.95	231	3,010
Mineral	717,500	2,365	6,551	.....	726,316	697,448	.96	206	922
Mingo	2,503,910	33,531	60,038	.....	2,597,479	2,518,305	.97	231	3,300
Monongalia	299,318	6,538	3,612	100,111	409,579	325,820	.80	240	299
Ohio	320,067	90,860	1,567	.....	412,494	408,384	.99	277	403
Preston	756,066	22,379	17,857	371,456	1,167,758	1,038,999	.89	243	1,303
Putnam	592,266	14,300	5,500	.....	612,066	730,260	1.19	243	980
Raleigh	4,994,524	45,916	93,777	.....	5,134,217	5,165,826	1.01	232	5,131
Randolph	379,609	10,421	8,677	217,703	616,410	527,913	.86	245	539
Taylor	836,922	5,370	7,688	21,872	871,852	655,989	.75	234	690
Tucker	1,171,351	8,572	40,725	49,930	1,270,578	1,242,301	.98	265	1,400
Upshur	40,659	4,133	1,082	13,456	59,330	46,966	.79	169	88
Other counties [a] and small mines	441,528	125,670	18,419	1,717	587,334	591,453	1.01	230	681
Total	60,549,194	1,209,142	1,251,670	3,776,681	66,786,687	62,792,234	.94	266	68,248

1913.

Barbour	1,350,250	5,700	27,547	31,804	1,415,301	$1,102,649	$0.78	227	1,234
Boone	438,735	2,845	4,276	.....	445,856	457,594	1.03	232	454
Braxton	277,281	1,919	3,317	.....	282,517	248,702	.88	220	237
Clay	364,572	2,348	4,376	.....	371,296	344,301	.93	241	280
Fayette	8,686,215	181,899	227,256	848,657	9,944,027	10,367,363	1.04	249	12,729
Gilmer	89,602	2,635	1,100	.....	93,337	96,316	1.03	211	151
Grant	204,729	851	17,465	.....	223,045	204,228	.92	242	264
Harrison	5,482,959	13,635	53,347	34,496	5,584,437	4,718,287	.84	209	5,128
Kanawha	5,165,027	110,134	97,792	.....	5,372,953	5,304,644	.99	209	7,493
Logan	4,595,398	91,405	64,214	2,499	4,753,516	4,544,140	.96	208	4,384
McDowell	14,417,048	199,716	284,838	1,596,845	16,498,447	17,713,909	1.07	234	16,276
Marion	5,678,643	25,903	190,766	157,360	6,052,672	5,497,820	.91	235	5,185
Marshall	663,471	183,708	18,870	.....	866,049	889,351	1.03	263	929
Mason	104,356	40,593	3,742	.....	148,691	155,266	1.04	219	291
Mercer	2,815,111	33,390	50,018	418,493	3,317,012	3,635,080	1.10	236	2,894
Mineral	841,709	2,820	6,946	.....	851,475	807,075	.95	236	932
Mingo	2,892,347	32,882	65,189	.....	2,990,418	2,878,750	1.07	242	2,965
Monongalia	239,248	26,968	5,137	123,287	394,640	340,649	.86	231	428
Ohio	346,613	64,544	1,483	.....	412,640	435,824	1.06	276	407
Preston	978,594	16,376	34,552	302,385	1,331,907	1,303,143	.98	265	1,420
Putnam	600,676	13,700	8,400	.....	622,776	765,304	1.23	266	1,036
Raleigh	5,503,813	91,765	102,003	.....	5,697,581	6,393,590	1.12	243	5,842
Randolph	387,038	7,295	9,941	244,097	648,371	582,194	.90	249	516
Taylor	1,011,155	5,207	10,053	20,355	1,046,770	839,322	.80	264	815
Tucker	1,200,705	12,075	34,444	46,265	1,293,489	1,214,094	.94	238	1,324
Upshur	76,399	3,470	1,407	15,546	96,822	80,854	.84	227	94
Other counties [b] and small mines	700,630	135,380	6,750	10,177	852,937	951,316	1.12	259	1,078
Total	64,812,324	1,309,163	1,335,229	3,852,266	71,308,982	71,872,165	1.01	234	74,786

[a] Grant, Greenbrier, Hancock, Lewis, Lincoln, Nicholas, Wayne, and Webster.
[b] Brooke, Greenbrier, Hancock, Lewis, Lincoln, Nicholas, Wayne, Webster, and Wyoming.

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The statistics of production, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912, are shown in the following table:

Coal production of West Virginia, by counties, 1909–1913, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Barbour	1,024,805	1,368,391	1,024,784	1,163,361	1,415,301	+ 251,940
Boone	.....	.....	160,523	379,976	445,856	+ 65,880
Braxton	105,714	167,123	209,167	234,988	282,517	+ 47,529
Brooke	380,887	470,674	451,430	494,471	448,255	− 46,216
Clay	43,212	44,602	146,713	212,125	371,296	+ 159,171
Fayette	9,877,521	10,410,983	9,976,784	9,636,230	9,944,027	+ 307,797
Gilmer	40,201	45,190	53,580	76,735	93,337	+ 16,602
Grant	190,575	283,072	209,530	199,926	223,045	+ 23,119
Hancock	75,633	71,211	49,200	2,980	7,435	+ 4,455
Harrison	3,385,291	4,641,304	4,241,098	5,171,772	5,584,437	+ 412,665
Kanawha	5,577,138	7,010,487	5,671,026	5,113,557	5,372,953	+ 259,396
Lincoln	51,227	71,917	81,770	67,212	58,740	− 8,472
Logan	2,147,965	2,896,328	3,149,671	4,196,744	4,753,516	+ 556,772
McDowell	11,964,836	13,488,076	13,386,749	15,809,289	16,498,447	+ 689,158
Marion	4,195,473	4,795,549	4,830,540	5,793,124	6,052,672	+ 259,548
Marshall	356,619	538,402	678,172	798,028	866,049	+ 68,021
Mason	117,209	221,217	201,943	131,303	148,691	+ 17,388
Mercer	2,511,000	2,876,834	2,924,714	3,109,571	3,317,012	+ 207,441
Mineral	892,245	883,586	610,727	726,316	851,475	+ 125,159
Mingo	2,039,640	2,442,630	2,341,000	2,597,479	2,690,418	+ 92,939
Monongalia	371,890	554,073	495,657	409,579	394,640	− 14,939
Nicholas	36,714	79,714	54,731	70,986	99,787	+ 28,801
Ohio	236,870	309,049	326,195	412,494	412,640	+ 146
Preston	996,767	1,164,382	870,447	1,167,758	1,331,907	+ 164,149
Putnam	575,009	540,632	568,222	612,066	622,776	+ 10,710
Raleigh	2,411,513	3,347,129	4,409,430	5,134,217	5,697,581	+ 563,364
Randolph	392,846	600,907	553,935	616,410	648,371	+ 31,961
Taylor	483,906	719,230	745,578	871,852	1,046,770	+ 174,918
Tucker	1,157,753	1,317,967	1,152,116	1,270,578	1,293,489	+ 22,911
Upshur	80,615	92,760	38,225	59,330	96,822	+ 37,492
Other counties and small mines	128,146	217,600	217,923	246,230	238,720	− 7,510
Total	51,849,220	61,671,019	59,831,580	66,786,687	71,308,982	+ 4,522,295
Total value	$44,661,716	$56,665,061	$53,670,515	$62,792,234	$71,872,165	+$9,079,931

The coal fields of West Virginia belong to the Appalachian region, all of the State west of the escarpment of the Allegheny Mountains being in the coal-bearing formation. The coal area contains about 17,000 square miles out of a total of 24,022 square miles in the State.

Nearly all of the production comes from seven principal mining districts, three in the northern part of the State and four in the southern part. The three principal districts in the northern part of West Virginia are the Fairmont (or Clarksburg), which includes Harrison and Marion counties; the Elk Garden (or Piedmont), which includes Mineral, Grant, and Tucker counties and is part of a detached basin extending northward into Maryland, where it is known as Georges Creek; and the Philippi district, which includes Preston, Barbour, and Randolph counties. The most important bed in the Fairmont and Elk Garden districts is the famous Pittsburgh, although in the Fairmont district the Waynesburg and the Sewickley coals are present, though but little worked, and in the Elk Garden the "Thomas" (Upper Freeport) and the "Davis" (Upper Kittanning) are present, both of which are extensively worked.

The four important districts in the southern part of the State are the New River, Kanawha, Pocahontas, and Big Sandy.

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The New River district, as its name implies, is chiefly within the area drained by New River and its tributaries, but includes also the drainage areas of Slab Fork and Winding Gulf, tributaries of Guyandot River. The productive portions are in Fayette and Raleigh counties, though some of the coal mined in the western part of Fayette County belongs to the coal series of the Kanawha district. The principal beds worked are the Sewell, the Beckley, and the Quinnimont.

Most of the New River coal is a high-grade "smokeless" coking coal, much prized for its steaming as well as its coking quality.

The Kanawha district lies immediately west of the New River field. It includes all of Kanawha County and parts of Putnam and Boone counties. Eight different beds are worked, of which the Eagle and "No. 2 Gas" are the most important. The others are the Coalburg, North Coalburg, No. 5, Stockton, Winifrede, and Cedar Grove.

The Pocahontas district lies in the extreme southern corner of the State in McDowell and Mercer counties and extends across the State line into Tazewell County, Va. It produces the celebrated high-carbon Pocahontas steaming and coking coal, one of the purest coals in the United States, mined from the "No. 3" bed. Pocahontas No. 4 has been extensively developed in recent years. Other beds known locally as the War Creek (Beckley), the Welch, and the Davey (Sewell) are also mined.

The Big Sandy district, like the Philippi in the northern part of the State, has become of importance through recent development. It is really a continuation of the Kanawha field into Logan and Mingo counties, and the beds worked are those of the Kanawha district.

The coals of West Virginia are all of bituminous or semibituminous variety, and mostly high grade. Some cannel and a peculiar type known as splint are mined in the southern part of the State.

The statistics of coal production in West Virginia since 1863, when the State was formed out of Virginia, to the close of 1913 are shown in the following table:

Production of coal in West Virginia, 1863–1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1863	444,648	1877	1,120,000	1891	9,220,665	1905	37,791,580
1864	454,888	1878	1,120,000	1892	9,738,755	1906	43,290,350
1865	487,897	1879	1,400,000	1893	10,708,578	1907	48,091,583
1866	512,068	1880	1,829,344	1894	11,627,757	1908	41,897,843
1867	589,360	1881	1,680,000	1895	11,387,061	1909	51,849,220
1868	609,227	1882	2,240,000	1896	12,876,296	1910	61,671,019
1869	603,148	1883	2,335,833	1897	14,248,159	1911	59,831,580
1870	608,878	1884	3,360,000	1898	16,700,999	1912	66,786,687
1871	618,830	1885	3,369,062	1899	19,252,995	1913	71,308,982
1872	700,000	1886	4,005,796	1900	22,647,207		
1873	1,000,000	1887	4,881,620	1901	24,068,402	Total...	787,543,870
1874	1,120,000	1888	5,498,800	1902	24,570,326		
1875	1,120,000	1889	6,231,880	1903	29,337,241		
1876	896,000	1890	7,394,654	1904	32,406,752		

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WYOMING.

Total production in 1913, 7,393,066 short tons; spot value, $11,510,045.

Wyoming's coal production in 1913 showed only a small increase (24,942 short tons) over 1912 in quantity, and this was accompanied by an apparent decline of 2 cents in the average price per ton, which resulted in a decrease of $138,043 in the total value. This decrease in value, however, is probably not an actual loss. Reports from Sweetwater County, which produces nearly 40 per cent of the total for the State, show a decline in the average value per ton from $1.69 in 1912 to $1.64 in 1913. The output from Sweetwater County is largely from mines controlled by the Union Pacific Railroad, and this portion of the product is not commercial coal, but is consumed entirely by the controlling interests. The placing of a value on it is purely arbitrary and does not represent market conditions. In Lincoln County a large part of the production is also controlled by railroad interests, and this county also showed a slight decline in the average value, while in Sheridan County, whose product is chiefly commercial coal, there was a slight advance. Conditions were generally satisfactory throughout the year, and up to the last quarter of the year production was considerably ahead of the corresponding period in 1912, but the exceptionally mild weather in the last three months of 1913 materially affected the commercial demand and reduced production to below the normal for that part part of the year. The labor situation was entirely satisfactory throughout 1913, operators and miners working harmoniously under a contract signed on September 1, 1912, and there was not a single strike or lockout reported. The troubles between operators and the miners' union in Colorado benefited Wyoming by an influx of labor from the Colorado fields and increased the demand for domestic coal from Kansas, Nebraska, and northern Colorado.

There was a slight improvement in demand for railroad coal, due to increased business in transportation, and a small increase was noted in the demand for slack at furnaces in Colorado and Utah. A drought in southern Nebraska and Kansas released for coal use a considerable railroad equipment usually in demand for hauling crops, so that the customary complaint of short car supply was lacking, except for a short period in October.

In 1912 a new county, Lincoln, was carved out of Uinta County, and in 1913 the portion of Big Horn County in which coal is mined was made into Hot Springs County, Big Horn ceasing to be a coal-producing county.

Wyoming continues to maintain a high record for efficiency in the rate of production per man employed, though there was a slight falling off in the average tonnage for the year and per day in 1913 as compared with 1912. The number of men employed in 1913 was 8,331, who worked an average of 232 days in the production of 7,393,066 tons of coal, against 7,368,124 tons produced by 8,036 men working an average of 238 days in 1912. The average tonnage per man decreased from 917 in 1912 to 887 in 1913, and the average for each man per day decreased from 3.85 to 3.82 tons.

It is gratifying to record a decreased percentage in the production of "powder-mined" coal. In 1912, 3,180,067 tons, or more than

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40 per cent of the total, were shot off the solid. In 1913 that part of the output amounted to 2,719,884 tons, or not quite 37 per cent. The machine-mined production increased from 2,367,882 tons, or 32 per cent, in 1912 to 3,050,784 tons, or a little more than 41 per cent, in 1913. The coal mined by hand decreased from 1,810,559 tons, or 25 per cent, to 1,618,696 tons, or 22 per cent. The number of machines in use increased from 179 to 195, the latter including 84 chain-breast, 61 punchers, 27 short-wall, 11 long-wall, and 12 radial-axe or post machines.

Another gratifying record made by Wyoming in 1913 was a decrease in the number of fatalities reported by the Bureau of Mines. In 1912 there were 34 deaths by accident in the coal mines of Wyoming, and in 1913 there were 26, a decrease of 8, or 23.5 per cent. Of the deaths in 1913, 13, or just one-half, were due to falls of roof, 2 to falls of coal, and 4 to haulage-way accidents. Of the other 7 deaths, 2 occurred on the surface and 5 were due to miscellaneous causes underground. The record for the year was free of gas or dust explosions. The death rate per thousand in 1913 was 3.12, against 4.23 in 1912, and the number of tons mined for each life lost was 284,349, against 216,710.

The statistics of production, by counties, in 1912 and 1913, with the distribution of the product for consumption, are as follows:

Coal production of Wyoming in 1912 and 1913, by counties, in short tons.

1912.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total quantity.	Total value.	Average price per ton.	Average number of days active.	Average number of employees.
Bighorn	179,980	926	13,220	194,105	$371,481	$1.91	225	273
Carbon	604,504	9,057	23,450	637,011	1,009,262	1.58	288	675
Converse	11,451	1,930	1,500	14,881	27,631	1.86	109	79
Johnson	.....	7,675	175	7,850	13,944	1.78	218	9
Sheridan	1,050,995	17,684	17,603	1,086,282	1,324,793	1.22	201	1,233
Sweetwater	2,871,328	14,308	83,970	2,969,601	5,015,484	1.69	230	3,375
Uinta	438,819	13,793	37,078	489,690	720,308	1.47	268	530
Other counties[a]	1,836,206	11,708	114,477	1,962,391	3,153,969	1.61	258	1,862
Small mines	.....	6,313	.....	6,313	11,216	1.78	.....	.....
Total	6,993,263	83,388	291,473	7,368,124	11,648,088	1.58	238	8,036

1913.

Converse	5,000	2,011	100	7,111	$13,158	$1.85	239	14
Lincoln	1,735,243	11,469	124,749	1,871,461	2,854,434	1.53	271	1,960
Sheridan	1,177,761	18,470	14,936	1,211,167	1,486,215	1.23	186	1,333
Sweetwater	2,738,822	14,234	79,419	2,832,475	4,693,775	1.64	224	3,424
Other counties[b]	1,347,164	34,737	86,199	1,468,100	2,455,528	1.67	239	1,600
Small mines	.....	2,752	.....	2,752	6,935	2.52	.....	.....
Total	7,003,990	83,673	305,403	7,393,066	11,510,045	1.56	232	8,331

[a] Crook, Fremont, Lincoln, Park, and Weston.
[b] Carbon, Crook, Fremont, Hot Springs, Park, Johnson, Uinta, and Weston.

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The statistics of the production of coal, by counties, during the last five years, with increase and decrease in 1913 as compared with 1912, are shown in the following table:

Coal production of Wyoming, 1909–1913, by counties, in short tons.

County.	1909	1910	1911	1912	1913	Increase(+) or decrease (−), 1913.
Bighorn	133,389	181,259	172,884	194,105	.....	− 194,105
Carbon	590,969	665,659	597,496	637,011	615,430	− 21,581
Converse	16,885	8,950	16,992	14,881	7,111	− 7,770
Lincoln	.....	.....	.....	1,440,435	1,871,461	+ 431,026
Sheridan	970,165	1,303,354	1,140,466	1,086,282	1,211,167	+ 124,885
Sweetwater	2,641,860	2,875,449	2,628,202	2,969,601	2,832,475	− 137,126
Uinta	1,586,320	1,960,671	1,725,311	489,690	67,065	− 422,625
Weston	354,182	416,714	325,114	392,714	353,656	− 39,058
Crook, Fremont, Johnson	[a] 91,751	[a] 118,803	[a] 135,932	[a] 137,092	[b] 431,949	+ 294,857
Small mines	7,588	2,229	2,467	6,313	2,752	− 3,561
Total	6,393,109	7,533,088	6,744,864	7,368,124	7,393,066	+ 24,942
Total value	$9,896,848	$11,706,187	$10,508,863	$11,648,088	$11,510,045	−$138,043

[a] Crook, Fremont, Johnson, and Park counties.
[b] Crook, Fremont, Hot Springs, Johnson, and Park counties.

Probably more than half of the entire area of Wyoming is coal bearing. Coal is believed to exist in every county of the State, although in some portions it lies under such heavy cover as to be unworkable under present conditions. The reserves are estimated at approximately 424,000,000,000 short tons, a supply exceeding that of any other State, with the possible exception of North Dakota. The coals of the latter State, however, are almost entirely lignite, with a small amount of subbituminous coal, whereas those of Wyoming range from subbituminous to medium-grade bituminous. Some of the Wyoming coals go to markets as far distant as the Pacific coast. The coal fields of Wyoming are numerous, some of them of very large area, and contain many beds, some of them of great thickness. One bed in the southwestern part of the State is about 90 feet thick. The largest coal field in the area is the Powder River field, in the northeastern part of the State. It occupies a trough or basin between the Black Hills and the Big Horn Mountains and extends from the Montana line on the north to North Platte River on the south. At least 11,000 of the 15,000 square miles contained in this area are underlain by coal beds of known workable thickness. The principal mining operations are at Sheridan, Dietz, and Monarch, in Sheridan County, and at Cambria, in Weston County. The production in 1913 was 1,564,823 short tons, or about 20 per cent of the total output of the State. The Chicago, Burlington & Quincy Railroad furnishes transportation for and consumes a large part of the product.

Second in size but first in productive importance at the present time is the Green River basin in the southwestern part of the State. This field contains over 6,000 square miles believed to cover available coal. In addition to this, there are 20,000 square miles in which the coal beds are so deeply covered that their ultimate availability is doubtful. The principal mining operations are at Rock Springs, on the Union Pacific Railroad, in Sweetwater County, and some of the production in Carbon County is from this basin. Sweetwater County alone pro-

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duces 40 per cent of the State's total—2,832,475 tons out of a total of 7,393,066 tons in 1913.

The Bear River region in Uinta and Lincoln counties (Lincoln County having been created out of Uinta County in 1912) is relatively small in area but second in quantity of coal produced, having in 1913 an output of 1,938,526 tons, or more than 25 per cent of the State's total. The product is largely bituminous coal and comes chiefly from the Kemmerer district. Shipments are made over the Union Pacific Railroad.

A region that has assumed some importance in the last five years is the Big Horn basin, in the northern part of the State. In this district (at Gebo, Hot Springs County) is the one coal mine in the United States opened on public land and now operated on a royalty basis from the Federal Government under the supervision of the Bureau of Mines. In 1906, before railroad transportation was available, Big Horn County (now Hot Springs County) produced less than 5,000 tons; in 1913 the production was 271,910 tons.

The Hanna field, in the eastern part of Carbon County, is one of the older areas in point of development. The principal operations are the Union Pacific Coal Co.'s mines at Hanna, and most of the coal goes to the Union Pacific Railroad. This district produces a little less than 10 per cent of the State's total output.

The Green River and Bear River basins and a small area in Weston County produce bituminous coal. The output from the other districts is subbituminous. Other fields of minor importance are the Wind River basin, in Fremont County; the Henrys Fork field, in southern Sweetwater County; the Powder River field, in Natrona and Fremont counties; the Muddy Creek field, in the Shoshone Indian Reservation, in Fremont County; the Fall River basin and the Upper Green River field, in Uinta and Fremont counties; the Mount Leidy field, the Lander Peak field, and the Grays River field, in Uinta County.

The first production of coal in Wyoming was reported in 1865, one year later than the first reported output of coal in Colorado. This pioneer coal mining was probably carried on in connection with the construction of the Union Pacific Railroad. The total output in that year amounted to 800 tons. Five years later, when the railroad was completed, the production amounted to about 50,000 tons.

The growth of the coal-mining industry, indicating as it does the increase in population and in industrial development in the State since 1865 and up to the close of 1913, is shown in the following table:

Production of coal in Wyoming from 1865 to 1913, in short tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1865	800	1878	333,200	1891	2,327,841	1904	5,178,556
1866	2,500	1879	400,991	1892	2,503,539	1905	5,602,021
1867	5,000	1880	589,595	1893	2,430,311	1906	6,133,994
1868	6,925	1881	420,000	1894	2,417,463	1907	6,262,990
1869	49,382	1882	707,764	1895	2,246,911	1908	5,489,902
1870	50,000	1883	779,689	1896	2,229,624	1909	6,303,109
1871	147,328	1884	902,620	1897	2,597,886	1910	7,533,088
1872	221,745	1885	807,328	1898	2,863,812	1911	6,744,864
1873	259,700	1886	829,355	1899	3,837,302	1912	7,368,124
1874	219,061	1887	1,170,318	1900	4,014,602	1913	7,303,066
1875	300,808	1888	1,481,540	1901	4,485,374		
1876	334,550	1889	1,388,947	1902	4,429,491	Total	118,740,918
1877	342,853	1890	1,870,366	1903	4,635,293		

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RECENT PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY RELATING TO COAL, COKE, LIGNITE, AND PEAT.

Compiled by JOHN M. NICKLES.

The following is a list of the more important papers dealing with coal, coke, lignite, and peat, published by the United States Geological Survey since the preparation of the bibliography published in Mineral Resources of the United States for 1910. This supplementary list, like the complete list in the report for 1910, deals with the geologic work in the several States alphabetically arranged.

ALASKA.

The Bonnifield region, Alaska, by S. R. Capps. Bull. 501, pp. 54–62, 1912.
The mining industry in 1911, by Alfred H. Brooks. Bull. 520, pp. 42–43, 1912.
The Yentna district, Alaska, by Stephen R. Capps. Bull. 534, p. 72, map of coal distribution (Pl. III in pocket), 1913.
The Noatak-Kobuk region, Alaska, by P. S. Smith. Bull. 536, pp. 151–153, 1913.

COLORADO.

The coal resources of Gunnison Valley, Mesa and Delta counties, Colo., by E. G. Woodruff. Bull. 471, pp. 565–573, 1912.
Coal fields of Grand Mesa and the West Elk Mountains, Colo., by W. T. Lee. Bull. 510, 219 pp., 1912.

IDAHO.

Coal at Horseshoe Bend and Jerusalem Valley, Boise County, Idaho, by C. F. Bowen. Bull. 531, pp. 245–251, 1913.
Lignite in the Goose Creek district, Cassia County, Idaho, by C. F. Bowen. Bull. 531, pp. 252–262, 1913.
The Horseshoe Creek district of the Teton Basin coal field, Fremont County, Idaho, by E. G. Woodruff. Bull. 541, pp. 379–388, 1914.

ILLINOIS.

Geology and mineral resources of the Peoria quadrangle, Illinois, by J. A. Udden. Bull. 506, pp. 80–89, 1912.
Murphysboro-Herrin folio, Illinois, description by E. W. Shaw and T. E. Savage. Geol. Atlas U. S., folio 185, pp. 13–15, 1912.
Tallula-Springfield folio, Illinois, description by E. W. Shaw and T. E. Savage. Geol. Atlas U. S., folio 188, pp. 11–12, 1913.

KENTUCKY.

Kenova folio, Kentucky-West Virginia-Ohio, description by W. C. Phalen. Geol. Atlas U. S., folio 184, pp. 8–14, 1912.
The coal resources and general geology of the Pound quadrangle of Virginia and Kentucky, by Charles Butts. Bull. 541, pp. 165–221, 1914.

MISSOURI.

The coal resources of a part of northeastern Missouri, by F. C. Greene. Bull. 541, pp. 223–242, 1914.

MONTANA.

The southern extension of the Milk River coal field, Chouteau County, Mont., by L. J. Pepperberg. Bull. 471, pp. 359–383, 1912.
The electric coal field, Park County, Mont., by W. R. Calvert. Bull. 471, pp. 406–422, 1912.
The Livingston and Trail Creek coal fields, Park, Gallatin, and Sweetgrass counties, Mont., by W. R. Calvert. Bull. 471, pp. 384–405, 1912.
The Culbertson lignite field, Valley County, Mont., by A. L. Beekly. Bull. 471, pp. 319–358, 1912.
The Sidney lignite field, Dawson County, Mont., by Eugene Stebinger. Bull. 471, pp. 284–318, 1912.

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The Terry lignite field, Custer County, Mont., by F. A. Herald. Bull. 471, pp. 227–270, 1912.
The Glendive lignite field, Dawson County, Mont., by J. H. Hance. Bull. 471, pp. 271–283, 1912.
The Baker lignite field, Custer County, Mont., by C. F. Bowen. Bull. 471, pp. 202–226, 1912.
Geology of certain lignite fields in eastern Montana, by W. R. Calvert. Bull. 471, pp. 187–201, 1912.
The Little Sheep Mountain coal field, Dawson, Custer, and Rosebud counties, Mont., by G. S. Rogers. Bull. 531, pp. 159–227, 1913.
Coal in the Tertiary lake beds of southwestern Montana, by J. T. Pardee. Bull. 531, pp. 229–244, 1913.
Lignite in the vicinity of Plentywood and Scobey, Sheridan County, Mont., by C. M. Bauer. Bull. 541, pp. 293–315, 1914.
Geology and coal resources of the area southwest of Custer, Yellowstone, and Big-horn counties, Mont., by G. S. Rogers. Bull. 541, pp. 316–328, 1914.
Coal discovered in a reconnaissance survey between Musselshell and Judith, Mont., by C. F. Bowen. Bull. 541, pp. 329–337, 1914.
The Cleveland coal field, Blaine County, Mont., by C. F. Bowen. Bull. 541, pp. 338–355, 1914.
The Big Sandy coal field, Chouteau County, Mont., by C. F. Bowen. Bull. 541, pp. 356–378, 1914.

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The Coaldale coal field, Esmeralda County, Nev., by J. H. Hance. Bull. 513, pp. 313–322, 1913.

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The Tijeras coal field, Bernalillo County, N. Mex., by W. T. Lee. Bull. 471, pp. 574–578, 1912.
The Cerrillos coal field, Sante Fe County, N. Mex., by W. T. Lee. Bull. 531, pp. 285–312, 1913.
Geology and coal resources of the Sierra Blanca coal fields, Lincoln and Otero counties, N. Mex., by C. H. Wegemann. Bull. 541, pp. 419–452, 1914.

NORTH CAROLINA.

Coal on Dan River, North Carolina, by R. W. Stone. Bull. 471, pp. 137–169, 1912.

NORTH DAKOTA.

Lignite in the Fort Berthold Indian Reservation, N. Dak., north of Missouri River, by M. A. Pishel. Bull. 471, pp. 170–186, 1912.
Bismarck folio, North Dakota, description by A. G. Leonard. Geol. Atlas U. S., folio 181, pp. 6–7, 1912.
The Williston lignite field, Williams County, N. Dak., by F. A. Herald. Bull. 531, pp. 91–157, 1913.
Geology of the Standing Rock and Cheyenne River Indian Reservations, by W. R. Calvert, A. L. Beekly, V. H. Barnett, and M. A. Pishel. Bull. 575, pp. 26–49, 1914.

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Kenova folio, Kentucky-West Virginia-Ohio, description by W. C. Phalen. Geol. Atlas U. S., folio 184, pp. 8–14, 1912.

OREGON.

The Eden Ridge coal field, Coos County, Oreg., by C. E. Lesher. Bull. 541, pp. 399–418, 1914.
Mineral resources of southwestern Oregon, by J. S. Diller. Bull. 546, pp. 130–141, 1914.

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Foxburg-Clarion folio, Pennsylvania, description by E. W. Shaw and M. J. Munn. Geol. Atlas U. S., folio 178, pp. 12–13 (field edition, pp. 97–103), 1911.
Claysville folio, Pennsylvania, description by M. J. Munn. Geol. Atlas U. S., folio 180, pp. 12–13, 1912.
Barnesboro-Patton folio, Pennsylvania, description by M. R. Campbell, F. G. Clapp and Charles Butts. Geol. Atlas U. S., folio 189, pp. 10–11, 1913.

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Rhode Island anthracite, by George H. Ashley. Bull. 541, pp. 155–162, 1914.

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Coal near the Black Hills, Wyoming-South Dakota, by R. W. Stone. Bull. 499, 66 pp., 1912.

Geology of the Standing Rock and Cheyenne River Indian Reservations, by W. R. Calvert, A. L. Beekly, V. H. Barnett, and M. A. Pishel. Bull. 575, pp. 26–49, 1914.

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The Deep Creek district of the Vernal coal field, Uintah County, Utah, by C. T. Lupton. Bull. 471, pp. 579–594, 1912.

The Blacktail (Tabby) Mountain coal field, Wasatch County, Utah, by C. T. Lupton. Bull. 471, pp. 595–628, 1912.

Coal near Thompson, Grand County, Utah, by F. R. Clark. Bull. 541, pp. 453–477, 1914.

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VIRGINIA.

Coking coal in Powell Mountain, Scott County, Va., by M. R. Campbell. Bull. 541, pp. 163–164, 1914.

The coal resources and general geology of the Pound quadrangle of Virginia and Kentucky, by Charles Butts. Bull. 541, pp. 165–221, 1914.

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Coal resources of Cowlitz River Valley, Cowlitz and Lewis counties, Wash., by A. J. Collier. Bull. 531, pp. 323–330, 1913.

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The Little Powder River coal field, Campbell County, Wyo., by J. A. Davis. Bull. 471, pp. 423–440, 1912.

Coal fields of the Wind River region, Fremont and Natrona counties, Wyo., by E. G. Woodruff and D. E. Winchester. Bull. 471, pp. 516–564, 1912.

The Lost Spring coal field, Converse County, Wyo., by D. E. Winchester. Bull. 471, pp. 472–515, 1912.

Coal near the Black Hills, Wyoming-South Dakota, by R. W. Stone. Bull. 499, 66 pp., 1912.

The Barber coal field, Johnson County, Wyo., by C. H. Wegemann. Bull. 531, pp. 263–284, 1913.

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Analyses of coal samples from various fields in the United States. Bull. 541, 1914.

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DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

THE PRODUCTION OF PETROLEUM IN 1913

By DAVID T. DAY

Mineral Resources of the United States, Calendar Year 1913—Part II
(Pages 929–1284)

WASHINGTON
GOVERNMENT PRINTING OFFICE
1914

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CONTENTS.

	Page.
Introduction	929
Production	929
World's production	930
Prices	930
General conditions	930
Stocks	931
Method of collecting statistics	932
Acknowledgments	934
Production	935
Rank of producing States	936
Quantity	936
Value	937
Production of petroleum in the United States from 1859 to 1913, inclusive	937
World's production to end of 1913	940
In 1913 and in 1857–1913	941
1857–1913, by countries	941
Production by fields	944
Deliveries	946
Stocks	946
Well record, 1912 and 1913	948
Fuel oil	950
General statement	950
Consumption	951
Prices	952
Railroads	952
Use in United States Navy	955
Petroleum operators' statistics, 1912 and 1913	960
Pipe-line statistics	970
Appalachian oil field	970
General conditions	970
Production	971
Runs, stocks, and deliveries	975
Prices	980
Well record	982
Pennsylvania and New York	984
Development	984
Production	985
Well record	986
West Virginia	988
Development	988
Production	989
Well record	989
Kentucky	992
Development	992
Production	992
Well record	994
Tennessee	995
Ohio	996
Development	996
Production	996
Well record	997
Lima-Indiana oil field	1003
Production	1003
Runs, deliveries, and stocks	1006
Prices	1007
Well record	1008
Indiana	1011
Development	1011
Production	1011
Well record	1011

Digitized by Google

Pipe-line statistics—Continued. Page.
Illinois oil field ... 1014
General conditions ... 1014
Southeastern Illinois ... 1014
Shallow fields ... 1014
Crawford County ... 1015
Lawrence County ... 1015
Wabash County ... 1015
South central and western Illinois ... 1016
Clinton County ... 1016
Marion County ... 1016
Macoupin County ... 1016
Miscellaneous ... 1016
Production ... 1017
Runs, deliveries, and stocks ... 1018
Railroad shipments ... 1019
Prices ... 1020
Well record ... 1021
Mid-Continent oil field ... 1023
Production ... 1023
Runs, deliveries, and stocks ... 1026
Prices ... 1026
Well record ... 1027
Kansas ... 1029
Development ... 1029
Production ... 1030
Well record ... 1030
Oklahoma ... 1032
Development ... 1032
Production ... 1033
Osage County ... 1034
Glenn Pool ... 1036
Well record ... 1036
Gulf oil field ... 1039
General conditions ... 1039
Production ... 1039
Runs, deliveries, and stocks ... 1042
Prices ... 1042
Well record ... 1043
Texas ... 1045
Development ... 1045
Electra ... 1045
Moran ... 1045
Orange County ... 1046
Sourlake ... 1046
Toyah ... 1046
Production ... 1047
Railroad shipments ... 1050
Well record ... 1050
Northern Texas ... 1051
Coastal Texas ... 1053
Louisiana ... 1055
Development ... 1055
Caddo ... 1055
De Soto Parish ... 1056
Production ... 1056
Railroad shipments ... 1059
Well record ... 1060
California oil field ... 1062
General conditions ... 1062
Transportation ... 1064
Pipe-line ... 1064
Railroad ... 1066
Tank-steamer ... 1066
Production ... 1067
Field report ... 1070

Digitized by Google

Pipe-line statistics—Continued. Page.
Colorado oil field 1071
General conditions 1071
De Beque 1071
Oil shales in Colorado and Utah 1071
Production 1072
Field report 1074
Utah 1074
Development 1074
Field report 1075
Wyoming oil field 1075
Development 1075
Production 1076
Field report 1077
Missouri 1077
Michigan 1078
Arkansas 1078
New Mexico 1078
Washington 1078
Imports 1079
Exports 1080
Territorial shipments 1080
Foreign shipments 1081
General conditions 1081
Exports by fiscal years 1082
by calendar years 1085
Prices 1090
Foreign oil fields 1091
Canada 1091
Mexico 1094
Trinidad 1096
Guatemala 1097
Other Central America and West Indies 1097
Venezuela 1098
Colombia 1098
Equador 1098
Bolivia 1099
Peru 1099
Argentina 1101
Chile 1101
Russia 1102
General conditions 1102
Production 1103
Austria-Hungary 1107
Galicia 1107
Roumania 1109
Germany 1112
Great Britain 1112
New South Wales 1113
Italy 1113
British India 1113
Dutch East Indies 1114
Timor 1114
China 1115
Japan 1115
Philippine Islands 1117
New Zealand 1118
Africa 1118
Egypt 1118
Somaliland 1118
South Africa 1118
Analyses of petroleum from various parts of the United States 1121
General statement 1121
Method of analysis 1123
Analyses 1126
Survey publications on oil fields of the United States 1280

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ILLUSTRATIONS.

		Page.
PLATE III.	Curves showing the relation of viscosity to temperature for various fuel oils	958
IV.	Production, stocks, and prices in Mid-Continent field, by months, 1909–1913	1026
FIGURE 20.	Diagram showing quantity and value of petroleum produced in the United States, and the production of the world from 1859 to 1913	940
21.	Curves showing the relation of viscosity to temperature for various fuel oils	957

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Production of crude petroleum ..... In pocket.

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PETROLEUM.

By DAVID T. DAY.

INTRODUCTION.

The aim of this report is to show the developments of the crude petroleum industry during the year which ended December 31, 1913. In order to be concise, the report presupposes a knowledge of the oil fields both of the United States and of other countries as given in the previous reports of this series and limits the discussion in this regard to the new developments of 1913. These are mentioned in the treatment of individual States. Many statements also refer to events which occurred after the close of 1913 where mention of them is necessary for clearness. Some of the analyses of crude oil, for example, were made within the last six months. The developments of the industry are shown chiefly by the statement of the quantity and value of the petroleum produced in each field in 1913 and by the comparison of this output with the production in previous years. In order that the changes in production may be more clearly understood, a table is given showing the production of each State for all the years since the beginning of the industry in the United States, and a similar table shows the total production of all nations from the beginning. Technological data are introduced when necessary to explain changes in production and value.

Production.—The study of the domestic production of petroleum yields a story of progressive maxima for the last seven years, until in 1913 the product reached 248,446,230 barrels, or 33,126,164 metric tons. The yield of 1912 was 222,935,044 barrels, or 29,724,673 metric tons.

Although the product of 1912 exceeded all previous records, the yield of 1913 surpassed it by the greatest gain in any year since 1910. In fact, the increase of 1913 over 1912—more than 25,000,000 barrels—was greater than the total production in any year until 1880, and the output of 1913 equalled the total production of the United States for the first 25 years of the industry. The production of the United States in 1913 was greater than the world's production in 1906, seven years earlier.

Still more remarkable in regard to the growth of the domestic oil industry is the amount of money received by the producers. In 1912 this amounted to $164,213,247, or an average of 73.7 cents a barrel, and in 1913 this average was 95.4 cents a barrel, or a total of $237,121,388, a gain of $72,908,141 over 1912. This is the greatest

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gain for any year in the history of the industry, and the gain alone outvalues the total receipts for oil in any year up to and including 1899 and is greater than the value of the oil in all the years combined up to and including 1866.

These statistics show the quantity of oil produced in the United States since the beginning of the industry in 1859 to be 3,069,694,605 barrels and the total value to be $2,575,704,530.

World's production.—The world's production in 1913 was 381,508,916 barrels, or 50,929,576 metric tons, of which the United States produced 65.12 per cent. Russia still ranks next to the United States, and Mexico third.

Prices.—It is obvious from these figures that the condition of prices for oil was the feature of second greatest interest in 1913. At the end of 1912 oil of Pennsylvania grade sold for $2 a barrel. In January, 1913, the price began to rise rapidly, with increments of 5 or 10 cents at a time until it reached $2.50 a barrel. Usually each advance caused a proportionate rise in price of other grades of oil in all parts of the country except California, where the price relations were not affected by eastern conditions.

The higher prices of crude oils were largely neutralized in the refineries, where there was an evident tendency to turn out greater proportions of high-grade products, such as gasoline, the supply of which was also increased by its recovery from natural gas in larger quantity than in 1912. As a rule the prices of gasoline, lamp oils, lubricants, and paraffin wax remained low, and in some cases showed a decline due to a surfeit of kerosene. But the higher prices of crude oil were felt in the prices of fuel oil, which increased generally—except in the California trade. A few railroads returned to the use of coal.

The advance in prices of fuel oil within the last few years caused the Secretary of the Navy to propose the development of oil supplies by the Government from deposits tributary to the Atlantic and the Gulf coasts, in addition to the oil reserves for naval purposes already established on the Pacific coast. Under a resolution of Congress this proposition is now under investigation by a committee from the Departments of the Interior and the Navy.

General conditions.—As to the production of individual fields, there was no great variation in their relative importance. It is noteworthy that the normal decline in the oil fields of New York and Pennsylvania was changed into a slight increase under the spur of greatly increased prices. West Virginia and Ohio declined, but only slightly. Even in Indiana the decrease was subnormal, because of new developments on the western border of the State. The decline in Illinois was decided and reflected the inability of the producers to continue the development of new pools; the older localities had passed their prime and decline was inevitable. Nevertheless, wildcatting is still active in many widely separated regions in Illinois, as is shown by discoveries of some new deep sands southeast of Bridgeport and by the development of the New Plymouth pool, in the western-central region.

The great gains in production came from the Mid-Continent field and from California. In the Mid-Continent field more new drilling took place than in 1912. A few new pools such as the Wicey, Boston, Wheeler, and others, were developed, but the great increase came

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rather from the large number of wells drilled within known pools or on their edges. These new wells were so generally prolific that their production added greatly to the total. The Cushing pool, in Oklahoma, was extended in various directions; its output decreased for a few months, and then with active drilling to establish extensions on the south, southeast, and north the product, which had declined from 30,000 to 16,000 barrels, gradually rose again to over 30,000 barrels a day. Just at the close of the year a well on the edge of the Cushing region was drilled 600 feet deeper, to the Bartlesville sand, and a sensational flow was encountered. This started the general policy of drilling to the thick and prolific Bartlesville sand, and oil came with a rush. Stocks were accumulating heavily at the end of the year. Late in September a small amount of oil was obtained in a well drilled near Healdton, Carter County, in the southern part of the State. By the close of the year several other wells had been drilled in that locality which were sufficiently successful to arouse the excitement that proved justified in 1914.

At the close of 1912 consumption in California had so nearly balanced production as to encourage the producers and to defeat concerted effort toward the restriction of drilling. Many of the wells of 1913 were gushers of the phenomenal type and aided greatly in increasing the supply. The efforts to increase consumption succeeded fairly well, so that, except during the month of greatest production, September, when about 9,000,000 barrels were produced, consumption almost kept pace with output and the quantity sent to storage was less than 1,000,000 barrels. The Fullerton field continued to yield large gushers with sufficient frequency to justify the expense in reaching the unusual depth of the oil sands. The "West Side" fields of Kern County continued as strong factors in increasing the output of the State, and the Buena Vista Hills, Elk Hills, and other new districts gained in interest. Even the comparatively old Kern River field, near Bakersfield, sustained interest by wildcatting to the northwest, where the Standard Oil Co.'s well went into oil and aroused geologic and financial speculation over a large area. The product of the field, however, declined. Coalinga's year had many eventful features, including extensions of territory to the east and the discovery of additional deep sands yielding oils containing paraffin.

As to Texas and Louisiana, the Electra and the Burkburnett fields in Texas progressed satisfactorily and a new field was developed at Moran, in Shackelford County. In the Gulf field Sour Lake furnished a surprise by yielding gushers sufficient to increase the total yield and to contribute to a decline in prices. It became evident during the year that the prospects of increase in the Gulf region, together with the abundant Mexican field, presage a plentiful supply of fuel oil. The Caddo field proved as irregular as in previous years, but gushers were so frequent and so large as to keep up the supply. To the south the De Soto region furnished several large gushers. The consequent excitement was tempered by the advent of water from a substratum, but the importance of the region was demonstrated.

Stocks.—The apparent paradox of advance in oil prices in spite of increased production is easily explained by the absence of any but a merely negligible advance in stocks. In fact, the decline in the high-grade fields would have threatened the extinction of the Pennsylvania

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and New York industry, except for this stimulus of higher prices. It is evident that the great increase in the production of petroleum has aroused sufficient confidence in a permanent supply to cause capitalists to increase the consumptive capacity of pipe lines, refineries, and distributing agencies. Largest returns on such investment is dependent on running the plants to full capacity, and the greater the investment in large refining capacity the more instantly does any threatened shortage of supply stimulate an advance in price.

METHODS OF COLLECTING STATISTICS.

The act establishing the United States Geological Survey makes it a duty of this organization to examine the mineral resources and products of the United States, and accordingly for about 30 years the Survey has published annually a report showing the production of petroleum in the United States and describing the new fields discovered and the new markets opened to this product.

In the early years covered by these investigations the Survey was obliged to rely wholly upon statistics collected and contributed by the pipe-line and other oil-transportation companies and upon statements showing the quantities of oil delivered directly to refineries. These statistics have proved to be accurate as far as they go, but their value is increased by comparing them with the results of more extended and direct statistical inquiry described below. Further, the returns obtained from producers furnish valuable details as to the growth of individual oil pools, the yield and rate of decline of individual wells, the character of the oil in the separate pools, and the relations of the oil to the surrounding rocks—details that are necessary to a careful scrutiny of the industry. The facts thus ascertained are also valuable in the field work of the geologists of the Survey who are studying the country's petroleum resources.

The canvass of all the petroleum-producing companies was begun seven years ago and has been gradually developed with the purpose of obtaining from each operator a brief statement of his actual production. The general recognition of the necessity and value of this work by the oil companies, which now furnish to the Survey more than 14,000 contributions of statistical returns, has afforded statistics that are trustworthy and valuable, and the returns received from these companies serve to show the accuracy of the statistics annually collected from the pipe-line companies.

The statistics published in this volume thus represent the results of two independent systems of inquiry. Under one system every pipe-line company in the United States and all railroad companies that handle crude petroleum furnish directly to the Survey, on blanks supplied to them for that purpose, corrected statements of their runs soon after the close of the calendar year. These statements are supplemented by returns solicited from refineries that obtain their oil directly from wells and by other returns required to prevent duplication of statistics.

At the end of the calendar year for which the statistics are collected, statistical inquiries relating to the production of oil, the conditions of wells drilled and abandoned, the acreage owned and leased, and other subordinate matters are addressed to every oil producer in the

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United States. In the States of Illinois, Kansas, Michigan, Missouri, New Mexico, Oklahoma, and Pennsylvania the statistics of the producers have been collected in cooperation with the State geologists.

The totals obtained from the producers have gradually approached those obtained from the pipe lines, and as the returns from important producing States have given promise of eventually becoming complete they have been published separately in the report. Meanwhile the producers' statistics have been of substantial aid as a check or control upon the returns showing pipe-line runs and have added to the accuracy of the final statement, which is therefore not merely a pipe-line statement, even of the totals, but is one modified in many details by the producers' figures. It will always be impossible to make the statistics obtained by the two methods or by any other two methods "check" absolutely with each other, but as a check in the sense of a means of control each system is of vital aid to the other, and the producers' statistics have thus been useful from the beginning. In the new regions where pipe lines did not exist or were inadequate the producers' statistics have been invaluable.

The length of time necessary for canvassing all the producers each year is the one element which prevents completeness. Less than 1 per cent of the producers in 1913 objected to answering the questions. Instead of waiting until every producer responds, the returns are published as soon as the producers' figures have served the purpose of controlling and supplementing the pipe-line returns, and essential accuracy has thus been obtained. This can be well illustrated by a comparison with the final statistics of the preliminary statement showing the total production for the United States, issued by the Survey promptly at the end of 1913 and based essentially upon the pipe-line returns published for 11 months. This preliminary statement showed a production of 243,000,000 barrels, in round numbers, for the United States—a fairly close approximation to the 248,446,230 barrels shown as the final figures based on producers' returns, final pipe-line returns, and the returns of the railroads and the refineries. The principal difference was due to the increase in deliveries to refineries in Oklahoma and Kansas, the key to which was furnished by the returns from producers in those States—yet the producers' statistics vary from the pipe-line results in those States more than in most other States.

In California the producers' statistics have always been preferred to those of the pipe lines for an interesting reason: The pipe-line statistics of the Eastern States were developed long before the production of oil became significant in California. At first this California oil was not transported by pipe lines, but was largely delivered from loading racks direct to the railroads to be burned as fuel oil. It was obviously necessary to obtain the statistics from the producers and to control these by the receipts of railroads and other consumers. As the industry spread and pipe lines were developed the system of pipe-line statistics was introduced. At present the two systems agree within negligible limits, because the pipe-line figures are published promptly at the close of the year and are available for control of the later producers' figures. It seems evident that eventually the producers' statistics must outvalue in every way those obtained on the pipe-line basis. This has proved true for all other mineral industries, even natural gas.

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ACKNOWLEDGMENTS.

Because of the constant interest in the peculiarly sensational features of the oil industry, the work of the petroleum press in the United States and elsewhere is more complete and satisfactory than that of the technical press devoted to any other branch of the mineral industry. The general information printed every week from the extensive system of correspondence maintained by the petroleum press is deserving of special recognition by the public and is emphatically acknowledged in these reports. Without it the more complete statistical work of the Federal Government would be more expensive, and, therefore, to a large extent impracticable.

In the early days of the industry the Oil City Derrick, whose field reports have been accepted as authoritative, developed a system of statistical returns which have been of the utmost value to the public. Similar reports organized by the Independence Daily Reporter, the Oil and Gas Journal, of Tulsa, Okla., whose field reports are accepted for Texas and Louisiana, Fuel Oil, and Oil and Gas, and the Oil, Paint, and Drug Reporter, have been developed to a condition of extreme promptness and commendable accuracy.

In the California field the California Derrick, the California Oil World, and the Oil Age have developed similarly important and efficient systems of reports in a field where statistical accuracy was unusually difficult. In addition the Petroleum Gazette, Oildom, the Petroleum Age, the National Petroleum News, and many other papers have added to the large amount of detailed information available to the public.

Abroad the Journal Petroleum, the Rohölindustrie, the Moniteur du Pétrole Roumain, the Revue du Pétrole, the Petroleum Review and the Petroleum World, of London, and the Pétrole, of Paris, afford similar service concerning foreign countries.

The aid given in the preparation of this report on the production of petroleum in the United States, not only by the numerous reports in these papers, but by answers to much correspondence, has been of the greatest value and is most heartily acknowledged. The statistics of foreign countries have been obtained chiefly by direct correspondence with the officials of the governments concerned as well as by the aid of many private authorities.

The statistical work and compilation of tables has been under the charge of Miss Anne B. Coons, statistician.

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PRODUCTION.

The statement of the production of petroleum in 1912 and 1913 is given in detail by States in the tables which follow:

Total quantity and value of petroleum produced in the United States and the average price per barrel in 1912 and 1913, by States, in barrels.

State.	1912			1913		
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.
Alaska	(a)	(a)		(b)	(b)	
California	c 87,272,593	c $39,624,501	$0.454	97,788,525	$45,709,400	$0.467
Colorado	206,052	199,661	.973	188,799	174,779	.926
Illinois	28,601,308	24,332,605	.851	23,893,899	30,971,910	1.296
Indiana	970,009	885,975	.913	956,095	1,279,226	1.337
Kansas	1,592,796	1,095,658	.688	2,375,029	2,248,283	.947
Kentucky	484,368	424,842	.877	524,568	675,748	1.288
Louisiana	9,263,439	7,023,827	.758	12,498,828	12,255,931	.981
Michigan	(d)	(d)		(b)	(b)	
Missouri				(b)	(b)	
New Mexico				(b)	(b)	
New York	874,128	1,401,880	1.604	902,211	2,169,357	2.404
Ohio	e 8,969,007	e 12,085,998	1.347	8,781,468	17,538,452	1.997
Oklahoma	51,427,071	34,672,604	.674	63,579,384	59,581,948	.937
Pennsylvania	7,837,948	12,886,752	1.644	7,963,282	19,805,452	2.487
Texas	11,735,057	8,852,713	.754	15,009,478	14,675,593	.978
West Virginia	12,128,962	19,927,721	1.643	11,567,299	28,828,814	2.492
Wyoming	1,572,306	796,470	.507	2,406,522	1,187,232	.493
Other States				f 10,843	f 19,263	1.777
Total	222,935,044	164,213,247	.737	248,446,230	237,121,388	.954

a Included in California.
b Included in other States.
c Includes Alaska.
d Included in Ohio.
e Includes Michigan.
f Includes Alaska, Michigan, Missouri, and New Mexico.

Total production of petroleum and percentage of increase or decrease, by States, in 1913, as compared with 1912, in barrels.

State.	Production.		Increase.	Decrease.	Percentage.	
	1912	1913			Increase.	Decrease.
Alaska	(a)	(b)				
California	c 87,272,592	97,788,525	10,515,932		12.05	
Colorado	206,052	188,799		17,253		8.37
Illinois	28,601,308	23,893,899		4,707,409		16.45
Indiana	970,009	956,095		13,914		1.43
Kansas	1,592,796	2,375,029	782,233		49.111	
Kentucky	484,368	524,568	40,200		8.300	
Louisiana	9,263,439	12,498,828	3,235,389		34.93	
Michigan	(d)	(b)				
Missouri		(b)				
New Mexico		(b)				
New York	874,128	902,211	28,083		3.212	
Ohio	e 8,969,007	8,781,468		187,539		2.09
Oklahoma	51,427,071	63,579,384	12,152,313		23.63	
Pennsylvania	7,837,948	7,963,282	125,334		1.60	
Texas	11,735,057	15,009,478	3,274,421		27.90	
Wyoming	1,572,306	2,406,522	834,216		53.056	
West Virginia	12,128,962	11,567,299		561,663		4.631
Other States f		10,843	10,843			
Total	222,935,044	248,446,230	25,511,186		11.44	

a Included in California.
b Included in other States.
c Includes Alaska.
d Included in Ohio.
e Includes production of Michigan.
f Includes Alaska, Michigan, Missouri, and New Mexico.

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RANK OF STATES.

QUANTITY.

The rank of the three great producing States, California, Oklahoma, and Illinois, remained the same in 1913 as in 1912, and there were few changes in the States of lower rank, though the increased production in northern Texas and northern Louisiana advanced those States above West Virginia. In the less productive States, Wyoming exceeded Kansas by a hundredth of 1 per cent of the total; both States showed increased production.

As to the outlook for 1914, it is evident from the general conditions that Oklahoma will approach much more closely to California and that the Mid-Continent field as a whole will assume the dominant position. Similarly an increase in Texas and a decrease in Illinois in 1914 will probably change the relative position of those States.

Rank of petroleum-producing States, with quantity and percentage of total produced by each in 1912 and 1913, in barrels.

State.	1912			State.	1913		
	Rank.	Quantity.	Percentage.		Rank.	Quantity.	Percentage.
California	1	[a] 87,272,593	39.15	California	1	97,788,525	39.356
Oklahoma	2	51,427,071	23.07	Oklahoma	2	63,579,384	25.59
Illinois	3	28,601,308	12.83	Illinois	3	23,893,899	9.62
West Virginia	4	12,128,962	5.44	Texas	4	15,009,478	6.04
Texas	5	11,735,057	5.26	Louisiana	5	12,498,828	5.03
Louisiana	6	9,263,439	4.16	West Virginia	6	11,567,299	4.66
Ohio	7	[b] 8,969,007	4.02	Ohio	7	8,781,468	3.53
Pennsylvania	8	7,837,948	3.52	Pennsylvania	8	7,963,282	3.20
Kansas	9	1,592,796	.71	Wyoming	9	2,406,522	.97
Wyoming	10	1,572,306	.70	Kansas	10	2,375,029	.96
Indiana	11	970,009	.44	Indiana	11	956,095	.39
New York	12	874,128	.39	New York	12	902,211	.36
Kentucky	13	484,368	.22	Kentucky	13	524,568	.21
Colorado	14	206,052	.09	Colorado	14	188,799	.08
Alaska	15	[c]	.....	Alaska	15		
Michigan	16	[d]	.....	New Mexico	16	10,843	.004
				Missouri	17		
				Michigan	18		
Total	.....	222,935,044	100.00	Total	.....	248,446,230	100.000

[a] Includes Alaska.
[b] Includes Michigan.
[c] Included in California.
[d] Included in Ohio.

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VALUE.

The one significant change in the relative value of the petroleum produced in the several States was the reversal of rank of California and Oklahoma, by which the latter State took first place by a large margin. This change was due not only to the great gain in production in Oklahoma but to the increased prices paid for Oklahoma oil, whereas in California there was almost no gain in price during 1913. The other States remained in about the same relative positions as in 1912, except that Kansas and New York changed places.

Rank of petroleum-producing States with regard to value of production and percentage of total of each in 1912 and 1913.

State.	1912			State.	1913		
	Rank.	Value.	Percentage.		Rank.	Value.	Percentage.
California	1	a$39,624,501	24.13	Oklahoma	1	$59,581,948	25.13
Oklahoma	2	34,672,604	21.11	California	2	45,709,400	19.28
Illinois	3	24,332,605	14.82	Illinois	3	30,971,910	13.06
West Virginia	4	19,927,721	12.13	West Virginia	4	28,828,814	12.16
Pennsylvania	5	12,886,752	7.85	Pennsylvania	5	19,805,452	8.35
Ohio	6	b 12,085,998	7.36	Ohio	6	17,538,452	7.40
Texas	7	8,852,713	5.39	Texas	7	14,675,593	6.19
Louisiana	8	7,023,827	4.28	Louisiana	8	12,255,931	5.17
New York	9	1,401,880	.85	Kansas	9	2,248,283	.95
Kansas	10	1,095,698	.67	New York	10	2,169,357	.91
Indiana	11	885,975	.54	Indiana	11	1,279,226	.54
Wyoming	12	798,470	.49	Wyoming	12	1,187,232	.50
Kentucky	13	424,842	.26	Kentucky	13	675,748	.28
Colorado	14	199,661	.12	Colorado	14	174,779	.07
Alaska	15	(c)	.....	Alaska	15		
Michigan	16	(d)	.....	New Mexico	16	19,263	.01
				Missouri	17		
				Michigan	18		
Total	.....	164,213,247	100.00	Total	.....	237,121,388	100.00

a Includes Alaska. b Includes Michigan. c Included in California. d Included in Ohio.

PRODUCTION OF PETROLEUM IN THE UNITED STATES FROM 1859 TO 1913, INCLUSIVE.

In the following table will be found a statement of the production of petroleum from each producing State of the United States from the year 1859 to and including the production of the year 1913:

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Production of petroleum in the United States, 1859–1913,

Year.	Pennsylvania and New York.	Ohio.	West Virginia.	California.	Kentucky and Tennessee.	Colorado.	Indiana.	Illinois.
1859	2,000	.....	.....	.....	.....	.....	.....	.....
1860	500,000	.....	.....	.....	.....	.....	.....	.....
1861	2,113,609	.....	.....	.....	.....	.....	.....	.....
1862	3,056,690	.....	.....	.....	.....	.....	.....	.....
1863	2,611,309	.....	.....	.....	.....	.....	.....	.....
1864	2,116,109	.....	.....	.....	.....	.....	.....	.....
1865	2,497,700	.....	.....	.....	.....	.....	.....	.....
1866	3,597,700	.....	.....	.....	.....	.....	.....	.....
1867	3,347,300	.....	.....	.....	.....	.....	.....	.....
1868	3,646,117	.....	.....	.....	.....	.....	.....	.....
1869	4,215,000	.....	.....	.....	.....	.....	.....	.....
1870	5,260,745	.....	.....	.....	.....	.....	.....	.....
1871	5,205,234	.....	.....	.....	.....	.....	.....	.....
1872	6,293,194	.....	.....	.....	.....	.....	.....	.....
1873	9,893,786	.....	.....	.....	.....	.....	.....	.....
1874	10,926,945	.....	.....	.....	.....	.....	.....	.....
1875	8,787,514	.....	.....	.....	.....	.....	.....	.....
1876	8,968,906	31,763	120,000	12,000	.....	.....	.....	.....
1877	13,135,475	29,888	172,000	13,000	.....	.....	.....	.....
1878	15,163,462	38,179	180,000	15,227	.....	.....	.....	.....
1879	19,685,176	29,112	180,000	19,858	.....	.....	.....	.....
1880	26,027,631	38,940	179,000	40,552	.....	.....	.....	.....
1881	27,376,509	33,867	151,000	99,862	.....	.....	.....	.....
1882	30,053,500	39,761	128,000	128,636	.....	.....	.....	.....
1883	23,128,389	47,632	126,000	142,857	4,755	.....	.....	.....
1884	23,772,209	90,081	90,000	262,000	4,148	.....	.....	.....
1885	20,776,041	661,580	91,000	325,000	5,164	.....	.....	.....
1886	25,798,000	1,782,970	102,000	377,145	4,726	.....	.....	.....
1887	22,356,193	5,022,632	145,000	678,572	4,791	76,295	.....	.....
1888	16,488,668	10,010,868	119,448	690,333	5,096	297,612	.....	.....
1889	21,487,435	12,471,466	544,113	808,220	5,400	316,476	33,375	1,460
1890	28,458,208	16,124,656	492,578	307,380	6,000	368,842	63,496	900
1891	33,009,236	17,740,301	2,406,218	323,600	9,000	665,482	136,634	675
1892	28,422,377	16,362,921	3,810,086	385,049	6,500	824,000	696,068	521
1893	20,314,513	16,249,769	8,445,412	470,179	3,000	594,390	2,335,293	400
1894	19,019,990	16,792,154	8,577,624	705,969	1,500	515,746	3,688,666	300
1895	19,144,390	19,545,233	8,120,125	1,208,482	1,500	438,232	4,396,132	200
1896	20,584,421	23,941,169	10,019,770	1,252,777	1,680	361,450	4,680,732	250
1897	19,262,066	21,560,515	13,090,045	1,903,411	322	384,934	4,122,356	500
1898	15,948,464	18,738,708	13,615,101	2,257,207	5,568	444,383	3,730,907	360
1899	14,374,512	21,142,108	13,910,630	2,642,095	18,280	390,278	3,848,182	360
1900	14,559,127	22,362,730	16,195,675	4,324,484	62,259	317,385	4,874,392	200
1901	13,831,996	21,648,083	14,177,126	8,786,330	137,259	460,520	5,757,086	250
1902	13,183,610	21,014,231	13,513,345	13,984,268	185,331	396,901	7,480,896	200
1903	12,518,134	20,480,286	12,899,395	24,382,472	554,286	483,925	9,186,411	.....
1904	12,239,026	18,876,631	12,644,686	29,649,434	998,284	501,763	11,339,124	.....
1905	11,554,777	16,346,660	11,578,110	33,427,473	1,217,337	376,238	10,964,247	181,084
1906	11,500,410	14,787,763	10,120,935	33,098,598	1,213,548	327,582	7,673,477	4,397,050
1907	11,211,606	12,207,448	9,095,296	39,748,375	820,844	331,851	5,128,037	24,281,973
1908	10,584,453	10,858,797	9,523,176	44,854,737	*f* 727,767	379,653	3,283,629	33,686,238
1909	10,434,300	10,632,793	10,745,092	55,471,601	*f* 639,016	310,861	2,296,086	30,898,339
1910	9,848,500	9,916,370	11,753,071	73,010,560	*f* 468,774	239,794	2,159,725	33,143,262
1911	9,200,673	8,817,112	9,795,464	81,134,391	*f* 472,458	226,926	1,695,289	31,317,038
1912	8,712,076	*a* 8,969,007	12,128,982	*g*87,272,593	*f* 484,368	206,052	970,009	28,601,308
1913	8,865,495	8,781,468	11,567,299	97,788,525	*f* 524,568	188,799	956,093	23,893,899
Total	745,070,906	424,225,652	250,552,782	641,498,232	8,593,529	10,426,370	101,488,342	210,406,867

a Includes the production of Michigan.
b Includes the production of Oklahoma.
c Included with Kansas.
d Estimated.
e Includes production of Utah.

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by years and by States, in barrels of 42 gallons.

Kansas.	Texas.	Missouri.	Oklahoma.	Wyoming.	Louisiana.	United States.	Total value.	Year.
.....	.....	.....	.....	.....	.....	2,000	$32,000	1859
.....	.....	.....	.....	.....	.....	500,000	4,800,000	1860
.....	.....	.....	.....	.....	.....	2,113,609	1,035,668	1861
.....	.....	.....	.....	.....	.....	3,056,690	3,209,525	1862
.....	.....	.....	.....	.....	.....	2,611,309	8,225,663	1863
.....	.....	.....	.....	.....	.....	2,116,109	20,896,576	1864
.....	.....	.....	.....	.....	.....	2,497,700	16,459,853	1865
.....	.....	.....	.....	.....	.....	3,597,700	13,455,398	1866
.....	.....	.....	.....	.....	.....	3,347,300	8,066,993	1867
.....	.....	.....	.....	.....	.....	3,646,117	13,217,174	1868
.....	.....	.....	.....	.....	.....	4,215,000	23,730,450	1869
.....	.....	.....	.....	.....	.....	5,260,745	20,503,754	1870
.....	.....	.....	.....	.....	.....	5,205,234	22,591,180	1871
.....	.....	.....	.....	.....	.....	6,293,194	21,440,503	1872
.....	.....	.....	.....	.....	.....	9,893,786	18,100,464	1873
.....	.....	.....	.....	.....	.....	10,926,945	12,647,527	1874
.....	.....	.....	.....	.....	.....	8,787,514	7,368,133	1875
.....	.....	.....	.....	.....	.....	9,132,669	22,982,822	1876
.....	.....	.....	.....	.....	.....	13,350,363	31,788,566	1877
.....	.....	.....	.....	.....	.....	15,396,868	18,044,520	1878
.....	.....	.....	.....	.....	.....	19,914,146	17,210,708	1879
.....	.....	.....	.....	.....	.....	26,286,123	24,600,638	1880
.....	.....	.....	.....	.....	.....	27,661,238	23,512,051	1881
.....	.....	.....	.....	.....	.....	30,349,897	23,631,165	1882
.....	.....	.....	.....	.....	.....	23,449,633	25,740,252	1883
.....	.....	.....	.....	.....	.....	24,218,438	20,476,924	1884
.....	.....	.....	.....	.....	.....	21,858,785	19,193,694	1885
.....	.....	.....	.....	.....	.....	28,064,841	20,028,457	1886
.....	.....	.....	.....	.....	.....	28,263,483	18,856,606	1887
.....	.....	.....	.....	.....	.....	27,612,025	17,950,363	1888
500	48	20	.....	.....	.....	35,163,513	26,963,340	1889
1,200	54	278	.....	.....	.....	45,823,572	35,365,105	1890
1,400	54	25	30	.....	.....	54,292,655	30,526,553	1891
5,000	45	10	80	.....	.....	50,514,657	25,950,463	1892
18,000	50	50	10	.....	.....	48,431,066	28,932,326	1893
40,000	60	8	130	2,369	.....	49,344,516	35,522,095	1894
44,430	50	10	37	3,455	.....	52,892,276	57,632,296	1895
113,571	1,450	43	170	2,878	.....	60,960,361	58,518,709	1896
81,098	65,975	19	625	3,650	.....	60,475,516	40,874,072	1897
71,980	546,070	10	.....	5,475	.....	55,364,233	44,193,359	1898
69,700	669,013	132	.....	5,560	.....	57,070,850	64,603,904	1899
74,714	836,089	[a] 1,602	6,472	5,450	.....	63,620,529	75,989,313	1900
179,151	4,393,658	[a] 2,335	10,000	5,400	.....	69,399,194	66,417,334	1901
331,749	18,083,658	[a] 757	37,100	6,253	548,617	88,766,916	71,178,910	1902
932,214	17,955,572	[a] 3,000	138,911	8,960	917,771	100,461,337	94,694,050	1903
4,250,779	22,241,413	[a] 2,572	1,366,748	11,542	2,958,958	117,060,960	101,175,455	1904
[b]12,013,495	28,136,189	[a] 3,100	(c)	8,454	8,910,416	134,717,580	84,157,399	1905
[b]21,718,648	12,567,897	[a] 3,500	(c)	[d] 7,000	9,077,528	126,493,936	92,444,735	1906
2,409,521	12,322,696	[a] 4,000	43,524,128	[e] 9,339	5,000,221	166,095,335	120,106,749	1907
1,801,781	11,206,464	[a] 15,246	45,798,765	[e] 17,775	5,788,874	178,527,355	129,079,184	1908
1,263,764	9,534,467	[a] 5,750	47,859,218	[e] 20,056	3,059,531	183,170,874	128,328,487	1909
1,128,668	8,899,266	[a] 3,615	52,028,718	[e] 115,490	6,841,395	209,557,248	127,899,688	1910
1,278,819	9,526,474	[a] 7,995	56,069,637	[e] 186,695	10,720,420	220,449,391	134,044,752	1911
1,592,796	11,735,057	[h]	51,427,071	1,572,306	9,263,439	222,935,044	164,212,247	1912
2,375,029	15,009,478	[e] 10,843	63,579,384	2,406,522	12,496,828	248,446,230	237,121,388	1913
51,798,007	183,731,197	64,920	361,847,234	4,404,569	75,585,998	3,069,694,605	2,575,704,530	Total.

[f] No production in Tennessee recorded.
[g] Includes small production of Alaska.
[h] No production in Missouri; Michigan included in Ohio.
[i] Includes production of Alaska, Michigan, and New Mexico.

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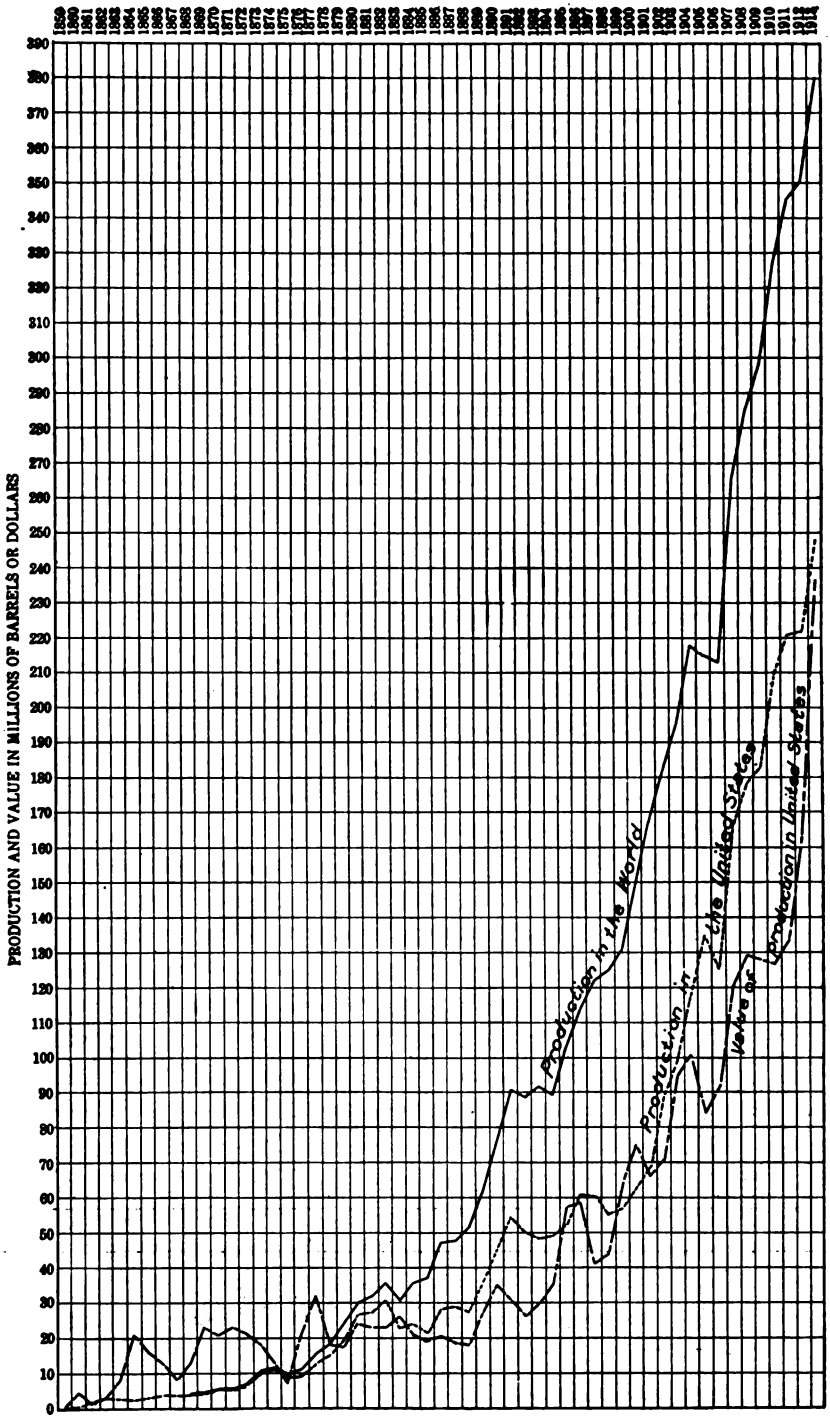
PRODUCTION AND VALUE IN MILLIONS OF BARRELS OR DOLLARS
Production in the World
Production in the United States
Value of Production in United States

FIGURE 20.—Diagram showing the quantity and value of petroleum produced in the United States, and the production in the world from 1859 to 1913.

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It should be noted that the total production of petroleum in the United States has now passed 3,000,000,000 barrels and that the value has passed $2,500,000,000. It required 42 years for the total production of petroleum from all the fields of the United States to reach the first billion barrels, and the same period of time to reach a total value of $1,000,000,000. In less than nine years the second billion barrels of oil was contributed, and with the rapid growth of the industry the third billion was the product of less than five years. At the present time (July 1, 1914) the production in the United States is in excess of one-fourth of a billion barrels a year. In other words, at the present rate the United States is producing as much oil in one year as was produced during the first 25 years of the petroleum industry.

WORLD'S PRODUCTION OF PETROLEUM FROM 1857 TO 1913, INCLUSIVE.

WORLD'S PRODUCTION IN 1913 AND IN 1857–1913.

The following table shows the world's production of crude petroleum in 1913 by countries, in barrels and metric tons, with percentage of total production for each country for the year, and also the total quantity produced by each country from the first industrial production in 1857 to the end of 1913, in barrels and metric tons, with percentage of total for each country:

World's production of crude petroleum in 1913 and in 1857–1913, by countries, in barrels and metric tons.

[Compiled by Anne B. Coons.]

Country.	Production, 1913.			Total production, 1857–1913.		
	Barrels.	Metric tons.	Percentage of total.	Barrels.	Metric tons.	Percentage of total.
United States	248,446,230	33,126,164	65.12	3,069,694,605	409,292,614	59.16
Russia	60,935,482	8,124,731	15.97	1,553,314,449	207,108,593	29.93
Mexico	25,696,291	3,426,172	6.74	68,965,294	9,195,373	1.33
Roumania	13,554,708	1,885,225	3.53	105,155,895	14,020,786	2.03
Dutch East Indies	11,966,857	1,534,223	3.14	125,573,184	16,743,091	2.42
Galicia	7,818,130	1,087,286	2.05	126,840,251	16,912,033	2.44
India	a 7,500,000	1,000,000	1.98	65,549,770	8,739,969	1.26
Japan	1,942,009	258,934	.51	24,312,780	3,241,704	.47
Peru	1,857,355	247,647	.49	12,113,264	1,615,102	.23
Germany	a 995,764	132,769	.27	11,969,805	1,595,974	.23
Canada	228,080	30,410	.06	23,278,805	3,103,841	.45
Italy	a 50,334	7,000	.01	765,759	102,101	.02
Other countries	517,616	69,015	.13	1,493,616	199,149	.03
Total	381,508,916	50,929,576	100.00	5,189,027,477	691,870,330	100.00

a Estimated.

The increase in the annual production of petroleum in the United States and the close relation which it bears to the total production of the world is illustrated on the accompanying diagram.

WORLD'S PRODUCTION, 1857-1913, BY COUNTRIES.

The following table shows the world's production by countries from 1857 to the end of 1913, in barrels:

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World's total production of crude petroleum, 1857–1913, by years and by countries, in barrels of 42 gallons.

[Compiled by Anne B. Coons.]

	Roumania.	United States.	Italy.	Canada.	Russia.	Galicia.	Japan.
1857	1,977	.....	.....	.....	.....	.....	.....
1858	3,560	.....	.....	.....	.....	.....	.....
1859	4,349	2,000	.....	.....	.....	.....	.....
1860	8,542	500,000	36	.....	.....	.....	.....
1861	17,279	2,113,609	29	.....	.....	.....	.....
1862	23,198	3,056,990	29	11,775	.....	.....	.....
1863	27,943	2,611,309	58	82,814	40,816	.....	.....
1864	33,013	2,116,109	72	90,000	64,586	.....	.....
1865	39,017	2,497,700	2,265	110,000	66,542	.....	.....
1866	42,534	3,597,700	992	175,000	83,052	.....	.....
1867	50,838	3,347,900	791	190,000	119,917	.....	.....
1868	55,369	3,646,117	367	200,000	88,327	.....	.....
1869	58,533	4,215,000	144	220,000	202,308	.....	.....
1870	83,765	5,260,745	86	250,000	204,618	.....	.....
1871	90,030	5,205,234	273	269,397	165,129	.....	.....
1872	91,251	6,293,194	331	308,100	184,391	.....	.....
1873	104,036	9,893,786	467	365,052	474,379	.....	.....
1874	108,177	10,926,945	604	168,807	583,751	149,837	.....
1875	108,569	8,787,514	813	220,000	697,364	158,522	4,566
1876	111,314	9,132,669	2,891	312,000	1,320,528	164,157	7,708
1877	108,569	13,350,363	2,284	312,000	1,800,720	169,792	9,560
1878	109,300	15,396,868	4,329	312,000	2,400,960	175,420	17,884
1879	110,007	19,914,146	2,891	575,000	2,761,104	214,800	23,457
1880	114,321	26,286,123	2,035	350,000	3,001,200	229,120	25,497
1881	121,511	27,661,238	1,237	275,000	3,601,441	286,400	16,751
1882	136,610	30,349,897	1,316	275,000	4,537,815	330,076	15,549
1883	139,486	23,449,633	1,618	250,000	6,002,401	365,160	20,473
1884	210,667	24,218,438	2,855	250,000	10,804,577	408,120	27,923
1885	193,411	21,858,785	1,941	250,000	13,924,596	465,400	29,237
1886	168,606	28,064,841	1,575	584,061	18,006,407	305,884	37,916
1887	181,907	28,283,483	1,496	525,655	18,367,781	343,832	28,645
1888	218,576	27,612,025	1,251	695,203	23,048,787	466,537	37,436
1889	297,666	35,163,513	1,273	704,690	24,609,407	515,268	52,811
1890	383,227	45,823,572	2,998	795,030	28,691,218	659,012	51,420
1891	488,201	54,292,655	8,305	755,298	34,573,181	630,730	52,917
1892	593,175	50,514,657	18,321	779,753	35,774,504	646,220	63,901
1893	535,655	48,431,066	19,069	798,406	40,456,519	692,669	106,384
1894	507,255	49,344,516	20,552	829,104	36,375,428	949,146	171,744
1895	575,200	52,892,276	25,843	726,138	46,140,174	1,452,999	141,310
1896	543,348	60,960,361	18,149	726,822	47,220,633	2,443,080	197,062
1897	570,886	60,475,516	13,892	709,857	54,399,568	2,226,368	218,559
1898	776,238	55,364,233	14,489	758,391	61,609,357	2,376,108	265,389
1899	1,425,777	57,070,850	16,121	808,570	65,954,968	2,813,047	536,079
1900	1,628,535	63,620,529	12,102	913,498	75,779,417	2,346,505	866,814
1901	1,678,320	69,389,194	16,150	756,679	85,168,556	3,251,544	1,110,790
1902	2,059,935	88,766,916	18,933	530,624	80,540,044	4,142,159	1,193,038
1903	2,763,117	100,461,337	17,876	486,637	75,591,256	5,234,475	1,209,371
1904	3,599,026	117,080,960	25,476	552,575	78,536,055	5,947,383	1,419,473
1905	4,420,987	134,717,590	44,027	634,095	54,960,270	5,765,317	1,472,804
1906	6,378,184	126,493,936	53,577	569,753	58,897,311	5,467,967	1,710,768
1907	8,118,207	166,095,335	59,875	788,872	61,850,734	8,455,841	2,001,538
1908	8,252,157	178,527,355	50,966	527,987	62,186,447	12,612,295	2,070,145
1909	9,327,278	183,170,874	42,388	420,755	65,970,350	14,982,799	1,889,563
1910	9,723,806	209,557,248	50,830	315,395	70,336,574	12,673,688	1,930,661
1911	11,107,450	220,449,391	74,709	291,096	66,183,691	10,519,270	1,658,903
1912	12,976,232	222,935,044	53,778	243,338	68,019,208	8,535,174	1,671,405
1913	13,554,768	248,446,280	a50,334	228,080	60,935,382	7,818,130	1,942,009
Total	105,155,895	3,069,694,605	765,759	23,278,805	1,553,314,449	126,840,251	24,312,780

a Estimated.

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World's total production of crude petroleum, 1857–1913, by years and by countries in barrels of 42 gallons—Continued.

[Compiled by Anne B. Coons.]

	Germany.	India.	Dutch East Indies.	Peru.	Mexico.	Other countries.	Total.
1857							1,977
1858							3,560
1859							6,349
1860							508,578
1861							2,130,917
1862							3,091,692
1863							2,762,940
1864							2,303,780
1865							2,715,524
1866							3,899,278
1867							3,708,846
1868							3,990,180
1869							4,695,985
1870							5,799,214
1871							5,730,063
1872							6,877,267
1873							10,837,720
1874							11,933,121
1875							9,977,348
1876							11,051,267
1877							15,753,938
1878							18,416,761
1879							23,601,405
1880	9,310						30,017,606
1881	29,219						31,992,797
1882	58,025						35,704,288
1883	26,708						30,255,479
1884	46,161						35,968,741
1885	41,360						36,764,730
1886	73,864						47,243,154
1887	74,284						47,807,083
1888	84,782						52,164,597
1889	68,217	94,250					61,507,095
1890	108,296	118,065					76,632,838
1891	108,029	190,131					91,100,347
1892	101,404	242,284					88,739,219
1893	99,390	298,969	600,000				92,038,127
1894	122,564	327,218	688,170				89,335,697
1895	121,277	371,536	1,215,757				103,662,510
1896	145,061	429,979	1,427,132	47,536			114,159,183
1897	165,745	545,704	2,551,649	70,831			121,948,575
1898	183,427	542,110	2,964,035	70,905			124,924,682
1899	192,232	940,971	1,795,961	89,166			131,143,742
1900	358,197	1,078,264	2,253,355	274,300			149,132,116
1901	313,430	1,430,716	4,013,710	274,300		[a] 20,000	167,424,089
1902	353,674	1,617,363	2,430,465	286,725		[a] 26,000	181,965,876
1903	445,818	2,510,259	5,770,056	278,962		[a] 36,000	194,804,294
1904	637,431	2,385,468	6,508,485	345,334	220,653	[a] 40,000	218,299,419
1905	560,963	4,137,098	7,849,896	447,380	320,379	[a] 30,000	215,361,296
1906	578,610	4,015,803	8,180,657	536,294	1,097,264	[a] 30,000	214,010,124
1907	756,631	4,344,162	9,982,597	756,226	1,717,690	[a] 30,000	264,958,008
1908	1,009,378	5,047,038	10,283,357	1,011,180	3,481,610	[a] 30,000	285,089,815
1909	1,018,837	6,676,517	11,041,852	1,316,118	2,488,742	[a] 30,000	298,326,073
1910	1,032,522	6,137,990	11,030,620	1,330,105	3,332,807	[a] 30,000	327,482,746
1911	1,017,045	6,451,203	12,172,949	1,368,274	14,051,643	[a] 200,000	345,545,624
1912	1,031,050	7,116,072	10,845,624	1,751,143	16,558,215	[b] 474,000	352,210,881
1913	[a] 995,764	[a] 7,500,000	11,966,857	1,857,355	25,696,291	[b] 517,616	381,508,916
Total	11,969,805	65,549,770	125,573,184	12,113,264	68,965,294	1,493,616	5,189,027,477

[a] Estimated. [b] Includes 461,986 barrels from Trinidad in 1912 and 503,616 barrels in 1913.

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PRODUCTION BY FIELDS.

It is customary to group the oil pools of the United States in certain fields. This grouping not only represents the geographic arrangement convenient with reference to the accessibility of the fields to market, but also points out certain more or less fundamental characteristics of the oils and their consequent adaptability to refining methods. Thus, the oils of the Appalachian field are simplest in composition, free from asphalt and objectionable sulphur, and capable of yielding products of the highest grade at minimum cost of refining. Contrasted with them is the petroleum of Lima, Ohio, and of the Indiana field. This contains little asphalt and consists chiefly of paraffin hydrocarbons similar to those in the Appalachian oils. But it is contaminated with sulphur compounds which necessitate unusual cost for their elimination by special processes. Once freed from the objectionable sulphur compounds the products are of high grade.

Most of the oils produced in Illinois can be refined without the use of any special process, but only with great care and with small yields of the more valuable products. Some of the oils are asphaltic; some are not.

Oils of the Mid-Continent field vary in composition within wide limits, from asphaltic oil, poor in gasoline and illuminants, among those found in Kansas and in the Healdton field of Oklahoma, to oils of much higher grade, especially those in the Cushing field of Oklahoma. The products extracted from the Healdton petroleum are of lower grade than from the other oils in Oklahoma (the Cushing pool, for example) on account of the sulphur, which approximates three times the average sulphur content of Oklahoma oils. This sulphur is present in a form resembling that of the Lima petroleum, and it has not been removed without special processes of refining.

The oils from the Gulf field are characterized by varying but considerable percentages of asphalt and low yields in the lighter products. They also contain sulphuretted hydrogen in solution and sulphur in other forms, the total percentage of sulphur being higher than in the Mid-Continent field or even in the Lima-Indiana field, but it can usually be more readily removed and without excessive cost.

The investigations of Prof. C. F. Mabery, of Cleveland, Ohio, and the experience of the oil refineries in the Gulf field have shown that lubricating oils of exceedingly high quality are produced from these Gulf oils. The quantity of lubricating oils that can be produced in the United States is far greater than the market demands; and hence, as the oils of the Appalachian, the Lima-Indiana, the Illinois, and the Gulf fields have proved valuable and amply sufficient for the market, the quality of the lubricating oils which can be produced from the other fields has been left as a practically untested matter.

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Production of petroleum in the United States, 1909–1913, by fields, in barrels.

Field.	1909	1910	1911	1912	1913
Appalachian	26,535,844	26,892,579	23,749,832	26,338,516	25,921,785
Lima-Indiana	8,211,443	7,253,861	6,231,164	[a] 4,925,906	4,773,138
Illinois	30,896,339	33,143,362	31,317,038	28,601,308	23,893,899
Mid-Continent	50,833,740	59,217,582	66,595,477	65,473,345	84,920,225
Gulf	10,883,240	9,680,465	10,999,873	8,545,018	8,542,494
California	55,471,601	73,010,560	81,134,391	[b] 87,272,593	97,788,525
Colorado and Wyoming	[c] 336,667	[c] 358,839	[c] 421,616	1,778,358	2,595,321
Other fields					[d] 10,843
Total	183,170,874	209,557,248	220,449,391	222,935,044	248,446,230

[a] Includes Michigan. [b] Includes Alaska. [c] Includes Michigan and Missouri. [d] Includes Alaska, Michigan, Missouri, and New Mexico.

Percentages of total production in the several fields, 1909–1913.

Field.	1909	1910	1911	1912	1913
Appalachian	14.49	12.83	10.77	11.81	10.430
Lima-Indiana	4.48	3.46	2.83	2.21	1.930
Illinois	16.87	15.82	14.21	12.83	9.620
Mid-Continent	27.75	28.26	30.21	29.37	34.180
Gulf	5.94	4.62	4.99	3.83	3.440
California	30.29	34.84	36.80	39.15	39.356
Colorado and Wyoming	.18	.17	.19	.80	1.040
Other fields					.004
Total	100.00	100.00	100.00	100.00	100.000

Production of petroleum in the United States in 1912 and 1913, by fields, showing percentage of increase or decrease, in barrels.

Field.	Production.		Increase.	Decrease.	Percentage.	
	1912	1913			Increase.	Decrease.
Appalachian	26,338,516	25,921,785		416,731		1.58
Lima-Indiana	[a] 4,925,906	4,773,138		152,768		3.10
Illinois	28,601,308	23,893,899		4,707,409		16.45
Mid-Continent	65,473,345	84,920,225	19,446,880		29.70	
Gulf	8,545,018	8,542,494		2,524		.03
California	[b] 87,272,593	97,788,525	10,505,932		12.05	
Colorado and Wyoming	1,778,358	2,595,321	816,963		45.94	
Other fields		[c] 10,843	10,843			
Total	222,935,044	248,446,230	25,511,186		11.44	

[a] Includes Michigan. [b] Includes Alaska. [c] Includes Alaska, Michigan, Missouri, and New Mexico.

Quantity, total value, and average price per barrel received at wells for petroleum produced in the United States in 1912 and 1913, by fields, in barrels.

Field.	1912			1913		
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.
Appalachian	26,338,516	$42,818,384	$1.626	25,921,785	$63,708,961	$2.458
Lima-Indiana	[a] 4,925,906	[a] 4,794,784	.932	4,773,138	6,588,068	1.380
Illinois	28,601,308	24,332,605	.851	23,893,899	30,971,910	1.296
Mid-Continent	65,473,345	45,300,669	.692	84,920,225	80,767,758	.951
Gulf	8,545,018	6,344,173	.742	8,542,494	7,993,997	.936
California	[b] 87,272,593	[b] 39,624,501	.454	97,788,525	45,709,400	.467
Colorado and Wyoming	1,778,358	998,131	.561	2,595,321	1,362,011	.525
Other fields				[c] 10,843	[c] 19,265	1.227
Total	222,935,044	164,213,247	.737	248,446,230	237,121,388	.954

[a] Includes Michigan. [b] Includes Alaska. [c] Includes Alaska, Michigan, Missouri, and New Mexico.

Deliveries to trade of petroleum and purposes for which shipped in 1912 and 1913, by fields, in barrels.

Field.	1912			1913		
	Delivered for—		Total.	Delivered for—		Total.
	Refining.	Fuel.		Refining.	Fuel.	
Appalachian	a27,042,540	.....	27,042,540	b25,333,879	.....	25,333,879
Lima-Indiana	c 5,688,025	13,325	5,701,350	5,419,533	c 26,791	5,446,324
Illinois	36,820,455	134,985	36,955,440	31,316,426	d 43,790	31,360,216
Kansas-Oklahoma	e58,108,633	954,924	59,063,557	f56,697,071	3,893,693	60,590,764
Louisiana	6,122,753	4,693,135	10,815,888	10,946,262	1,818,766	12,765,028
Texas	g 7,574,605	4,528,310	12,102,915	g 9,227,608	4,438,723	13,666,331
California	h35,739,993	48,220,326	83,960,319	67,934,167	i29,104,358	97,038,525
Colorado and Wyoming	1,641,297	15,034	1,656,331	g 2,167,497	13,180	2,169,834
Other fields						10,843
Total	178,738,301	58,560,039	237,298,340	209,042,443	39,339,301	248,381,744

a Includes 55,812 barrels of lubricating oil.
b Includes 40,266 barrels of lubricating oil.
c Includes 3,221 barrels used for street sprinkling.
d Includes 2,155 barrels used for hog dip and street sprinkling.
e Includes 271,252 barrels shipped by rail that can not be classified.
f Includes 1,927,688 barrels shipped by rail that can not be classified.
g Includes small amount of lubricating oil.
h 6,000,000 barrels estimated as used for road oil and gas manufacture.
i Estimated.

STOCKS.

The total production of crude oil in 1913 amounted to 248,446,230 barrels. The deliveries to trade in the same period aggregated almost the same quantity—248,381,744 barrels. Stocks remained unchanged—122,869,702 barrels at the close of 1912 and 122,934,188 barrels at the close of 1913. The evident fact is most extraordinary that the consuming interests were able to absorb the greatest product ever recorded without adding to stocks. This result would have been impossible without important additions to the refining capacity of the country and similar additions to the facilities for transporting the products to markets here and abroad. The rate at which production has increased during the last few years foreshadowed the necessity for such manufacturing expansion, and on account of the phenomenal elasticity of the petroleum industry it has been met successfully.

Once provided, this vast refining capacity must continue to be supplied with sufficient crude oil. In spite of the increase of production, therefore, the logic of the situation called for higher prices because of the belief that as soon as the first flood of oil had passed from the fields which were causing an increase, a decline in production would deprive the refineries of the full complement of crude oil necessary for successful operation. The total stocks only suffice for six months' supply. Nevertheless those stocks represent one-eighth of a billion dollars invested in a raw material all of which contains dissolved gas and gasoline sufficient—so long as it is crude—to inflame when struck by lightning and to cause losses by evaporation and leakage. Only a 3 per cent loss of this crude material means a loss of over $7,000,000 a year, even under fairly normal conditions and with the application of most intelligent measures of conservation

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Such an investment of money has certainly not proved tempting in any country except the United States.

The obvious ideal method of furnishing an adequate supply of petroleum for commercial needs without the hazardous investment of enormous capital in stocks is to determine with the greatest geologic and engineering skill the reserve of oil underground in each locality and to allow it to remain there with sufficient wells drilled and capped ready to augment the supply at short notice. In spite of theoretical excellence, this scheme fails, however, for three reasons: First, the doubt of the consumer of crude oil as to whether the geologist and the engineer have correctly estimated the productive capacity of a region. This doubt was very thoroughly justified in earlier years by the inadequate knowledge of the conditions of accumulation of oil in the earth. It is even now only of considerable value where it has been supported by the actual drilling of wells, which, after their supply is determined, may be capped for future use. It was this doubt as to the ability of the oil regions to furnish an adequate supply, no less than the desire to control that supply, which led the Standard Oil Co., many years ago, to provide a cash market for oil. This second reason, that is, the ability of the oil producer to find an instant sale for his product, has in turn developed the third reason why oil is not allowed to remain in natural storage, and that is, if one lessee does not immediately take his oil from the earth, he loses because his neighbor who "offsets" him will drain the oil into his own tanks.

Just at this time, July, 1914, the conditions of oil production in the United States have developed into a position involving in all probability radical change in the economic conditions of the oil industry. The production and the known productive capacity of the oil lands in Oklahoma have increased beyond all expectation and reasonable demands, and the extension of oil fields in Texas and Louisiana indicates a possibility of further floods of oil that will require a rearrangement of the productive system. The condition in Oklahoma threatens the axiom that "oil has an instant spot value." So long as oil can be taken from the ground and sold for more than the cost of production so long will active drilling be continued and so long will agreements as to limiting production fail. The point at which the exploration for oil in a new region is no longer logical and the drilling should, therefore, naturally cease, depends upon the yield of the wells when drilled. Oil was probably profitable at 10 cents a barrel in Texas in 1901 on account of the size of the wells yielding it at Spindletop. But at this price all pumping wells would now be unprofitable, and even small flowing wells would not tempt the driller. It is the uncertainty of the size of the well which may be obtained that tempts the speculators in a new region and clouds any clear and rational plan of development of oil territory. The speculative tendency is well illustrated by the fact that in many parts of the United States oil shales could be mined and made to yield oil on a basis as safe and sane as the mining of coal. Nevertheless, few prominent oil producers would leave the speculative thrill of the oil fields for the unexciting development of oil shales.

The solution of the problem of sufficient stock of oil for the enormous refining capacity of the United States must in the future rest

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chiefly on more accurate knowledge of the supplies of oil under ground, and, based upon this, the consequent application by the State of rigid rules whereby it shall become impossible for one operator to interfere with the oil contained in the property of another.

Stocks of all grades of petroleum at the close of 1912 and 1913, in barrels.

Grade of oil.	Held by eastern pipe lines[a] and refineries.		In pipe line storage outside of eastern field.		Total.		Increase.	Decrease.
	1912	1913	1912	1913	1912	1913		
Pennsylvania[b]	3,804,483	4,387,718			3,804,483	4,387,718	583,235	
Lima	2,419,541	1,746,355			1,746,355			673,186
Illinois[c]	2,368,271	1,079,468	13,341,467	7,163,953	15,709,738	8,243,421		7,466,317
Kentucky	226,035	230,706			226,035	230,706	4,671	
Kansas, Oklahoma	2,034,695	2,569,305	46,350,913	51,179,952	48,385,608	53,749,257	5,363,649	
Texas			2,487,144	3,830,291	2,487,144	3,830,291	1,343,147	
Louisiana			2,137,274	1,871,074	2,137,274	1,871,074		266,998
California			49,552,392	48,302,392	47,552,392	48,302,392	750,000	
Colorado and Wyoming			147,487	572,974	147,487	572,974	425,487	
Total	10,853,025	10,013,552	112,016,677	112,930,636	122,869,702	122,934,188	64,486	

[a] These pipe lines connect with the delivering lines of the Illinois, Kansas, and Oklahoma fields and receive and transfer large quantities of these western oils to the Atlantic seaboard in addition to the oil from wells directly tributary to their own systems.
[b] Includes natural lubricating oil from Pennsylvania and West Virginia.
[c] Includes some Indiana oil of Illinois grade.

Stocks, runs, and deliveries to trade of petroleum in 1912 and 1913, by fields, in barrels.

Field.	Stocks Dec. 31, 1911.	Production in 1912.	Deliveries to trade in 1912.	Stocks Dec. 31, 1912.	Production in 1913.	Deliveries to trade in 1913.	Stocks Dec. 31, 1913.
Appalachian	4,734,542	26,338,516	27,042,540	4,030,518	25,921,785	25,333,879	4,618,424
Lima-Indiana	3,194,985	[a] 4,925,906	5,701,350	2,419,541	4,773,138	5,446,324	1,746,355
Illinois	24,063,870	28,601,308	36,955,440	15,709,738	23,893,899	31,360,216	8,243,421
Kansas, Oklahoma	54,429,298	53,019,867	59,063,557	48,385,608	65,954,413	60,590,764	53,749,257
Louisiana	3,689,723	9,263,439	10,815,888	2,137,274	12,498,828	12,765,028	1,871,074
Texas	2,855,002	11,735,057	12,102,915	2,487,144	15,009,478	13,666,331	3,830,291
California	44,240,118	[b] 87,272,593	83,960,319	47,552,392	97,788,525	97,038,525	48,302,392
Colorado and Wyoming	25,460	1,778,358	1,656,331	147,487	2,595,321	2,169,834	572,974
Other fields[c]					[c] 10,843	10,843	
Total	137,232,998	222,935,044	237,298,340	122,869,702	248,446,230	248,381,744	122,934,188

[a] Includes production in Michigan.
[b] Includes Alaska.
[c] Includes Alaska, Michigan, Missouri, and New Mexico.

WELL RECORD.

The following tables give the well record for the United States for 1912 and 1913, by fields:

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Well record in the United States in 1912 and 1913, by fields.

1912.

Field.	Wells completed.				Initial daily production (barrels).	
	Oil.	Gas.	Dry.	Total.	Total.	Average per well.
Appalachian:						
Pennsylvania and New York	1,911	239	322	2,472	6,771	3.5
Central and southeastern Ohio	846	411	460	1,717	24,193	28.6
West Virginia	1,062	361	234	1,657	109,804	103.4
Kentucky	112	5	61	178	1,943	17.3
Total	3,931	1,016	1,077	6,024	142,711	36.3
Lima-Indiana:						
Lima, Ohio	482	14	55	551	7,229	15.0
Indiana	65	4	20	89	1,083	16.7
Total	547	18	75	640	8,312	15.2
Illinois	980	23	257	1,260	65,686	67.0
Mid-Continent:						
Kansas	536	253	160	949	7,245	13.5
Oklahoma	4,712	438	843	5,993	228,886	48.6
Northern Texas	299	11	124	434	28,213	94.3
Caddo, La	239	52	62	353	84,098	351.9
Total	5,786	754	1,189	7,729	348,442	60.2
Gulf:						
Coastal Texas	353	.....	109	462	33,082	93.7
Coastal Louisiana	59	.....	25	84	25,520	432.5
Total	412	.....	134	546	58,602	142.2
Alaska	2	.....	.....	2	.....	.....
California	776	.....	71	847	.....	.....
Colorado	15	.....	13	28	.....	.....
Wyoming and Utah	59	.....	25	84	.....	.....
Michigan	6	.....	2	8	.....	.....
Miscellaneous	.....	.....	12	12	.....	.....
Total for 1912	12,514	1,811	2,855	17,180	.....	.....
Corresponding total for 1911	9,825	1,580	2,363	13,768	.....	.....

1913.

Appalachian:						
Pennsylvania and New York	3,420	310	521	4,251	8,958	2.6
Central and southeastern Ohio	1,246	342	603	2,191	16,302	13.1
West Virginia	1,285	441	339	2,065	34,835	27.1
Kentucky	133	8	69	210	2,215	16.7
Total	6,084	1,101	1,532	8,717	62,310	10.2
Lima, Ohio	873	9	90	972	11,181	12.8
Indiana	213	12	86	311	7,393	34.7
Total	1,086	21	176	1,283	18,574	17.1
Illinois	1,363	80	278	1,721	47,405	34.8
Mid-Continent:						
Kansas	1,422	334	260	2,016	22,467	15.8
Oklahoma	6,965	578	1,308	8,851	334,050	48.0
Northern Texas	581	10	208	799	57,435	98.9
Caddo, La	356	70	92	518	151,955	426.8
Total	9,324	992	1,868	12,184	565,907	60.7
Gulf:						
Coastal Texas	325	12	255	592	38,978	119.9
Coastal Louisiana	81	1	57	139	55,740	618.1
Total	406	13	312	731	94,718	233.3
Alaska	2	.....	.....	2	.....	.....
California	789	.....	67	856	.....	.....
Colorado	8	.....	13	21	.....	.....
Wyoming and Utah	34	.....	25	59	.....	.....
Michigan	4	.....	1	5	.....	.....
Miscellaneous	1	.....	10	11	.....	.....
Total for 1913	19,101	2,207	4,282	25,590	.....	.....
Corresponding total for 1912	12,514	1,811	2,855	17,180	.....	.....

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FUEL OIL.

GENERAL STATEMENT.

The use of oil in one form or another as fuel for generating power or for domestic heating should be considered under several conditions: First, where oil is the most efficient source of heat and power because of the absence or inadequate supply of cheaper fuel. This is the condition on the entire Pacific slope. Second, where the use of oil as fuel represents a means of disposing of excess accumulation of crude oil, residues, or distillates, for which no market is at hand. This condition frequently prevails in the newer fields of the United States; it always represents a means of disposal by the refineries of undesirable products which would otherwise go to waste. There is a third condition of use of crude oil or its products as fuel which is in a radically different class. This is its application to the generation of power by making steam or in internal-combustion engines in the Navy and the merchant marine. This use is not so strictly limited by the price.

The production of a sudden flood of new oil in any part of the world naturally carries with it the utilization of more or less of this oil for fuel when the price per barrel goes below the limit of competition with coal. Thus at present in Wyoming, although that State contains adequate supplies of coal, use is made of the otherwise unsalable products from the Casper refineries for locomotive service over long distances in that State. This use must naturally increase from the fact that the production of oil in Wyoming is extending faster than any possible adequate market for the heavier products.

Crude oil seldom remains cheap for a very long period, and therefore the supply for railroad use and for other fuel purposes is so unreliable that crude oil as a fuel has lost favor very rapidly, and recourse is eventually made to those products from the crude, which happen in the particular oil under consideration to more than supply the demand for those particular products.

A short time ago the separation of a given crude oil into marketable products was strictly limited by the quantity of these different products naturally occurring in the crude oil. But more advanced methods of refining have lately included the ability to break up the less salable products in crude oil, and thus increase to a very great extent the yields of those products which are most salable.

An interesting example of this is found in California, where the oils obtained a few years ago contained only small percentages of gasoline and kerosene, so that there was a very large quantity of heavier products from the oil, all of which happened to find a good market as fuel. At first, in order to make up the deficit in gasoline and kerosene, gasoline and light crude oils containing much gasoline were imported from Borneo and Sumatra; then recourse was made to extracting gasoline from such natural gas as occurs in association with oil and contains considerable quantities of gasoline vapor. Within the last two years, following this extraction of gasoline from natural gas, the supply of gasoline has also been augmented by cracking the heavy crude oils under pressure, with the resulting production of "motor spirit."

Within the last two years also, a more significant change has occurred. The oils recently produced, especially those from con-

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siderable depth, have shown a much greater content of gasoline and kerosene—so much so, indeed, that the effort to produce an adequate supply of gasoline has been overdone. This material, so much in demand in the eastern United States for automobile and other internal combustion engines, has glutted the market of the Pacific coast, with consequently greatly decreased prices.

It is evident that the ability of the refineries to furnish, from all kinds of crude oils, those products which are in greatest demand has enormously increased within the last few years. As a result there is much less of any waste product to be thrown into the waste tanks and sacrificed under the general term of fuel oil. The prices of this material rose significantly in all parts of the eastern fields. Low prices for fuel oil in the future will depend chiefly upon the production of oil of all grades, in such quantity that much of it can only find market as fuel.

Within the last few months, however, the tendency toward cheaper fuel oil has increased because of the producing of low-grade crude oils in larger quantity in the Gulf field of Louisiana and Texas—that is, at Vinton and Edgerly in Louisiana, in Orange County in Texas, and also at greater depth in the old fields of Sour Lake, Saratoga, and Batson, in Texas.

The Mid Continent fields are forcing the heavier oils of the Gulf region to find a market elsewhere, chiefly as fuel. These Gulf oils yield good lubricants, but only a small proportion of the supply can find a market for that limited use. Further, the large fleet of tank steamers lately built enables Mexican oils to invade the eastern coast of the United States. This makes it probable that a large use of fuel oil may become a feature in manufacturing enterprises of the east coast region, and that while this use is being developed careful study will be given to modern methods of burning oils in internal combustion engines. It should be borne in mind, however, that if this substitution of coal by oil receives very great favor the movement would easily overtax the limitations of all the tank steamers in the trade. In the meantime, the advantages of fuel oil for marine engines are so great that the navies of the world will demand it independent of its price, and the merchant marine will be obliged to give this matter extremely careful consideration. Should an outlet for fuel oils really be opened by one large trans-Atlantic steamship line, the effect upon the price of fuel oil would be marked.

CONSUMPTION.

The quantity of crude oil used as fuel in California may be estimated at 29,000,000 barrels, not including the fuel oil from topped California crude. The total fuel oil used in California in 1913 approximated 63,000,000 barrels. The use by railroads of oil from other fields than California and the fuel oil furnished from imported Mexican crude brought the total quantity of fuel oil consumed in the United States in 1913 to 83,000,000 barrels.

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PRICES.

The following table shows the relative increase in price of fuel oil during the last three years:

Average prices of fuel oil in bulk at New York, 1911–1913, in cents per gallon.

Months.	1911	1912	1913
January	2.53	2.48	3.35
February	2.63	2.50	3.40
March	2.38	2.56	3.58
April	2.19	2.55	3.49
May	2.19	2.48	3.55
June	2.17	2.69	3.61
July	2.16	2.75	3.44
August	2.16	2.81	3.43
September	2.34	2.93	3.31
October	2.39	2.86	3.43
November	2.44	3.05	3.58
December	2.47	2.99	3.58

RAILROADS.

It has been customary to gage the use of oils for fuel in the United States largely by the consumption by railroads, because the statistics of such consumption may, by careful inquiry, be obtained with approximate accuracy, while consumption in other lines of industry is extremely difficult of determination.

The use of fuel oil by the railroads of Texas was originally due to the sudden flood of cheap oil from the Beaumont region in 1901. The continuance of this trade has lately been aided by imports from Mexico. The ease with which these Texas oils can find other markets than the railroads and the fact that the railroads can return to coal without very serious disadvantage make the future of locomotive consumption of fuel oils in Texas uncertain.

In California the railroads were the first to absorb large quantities of California oils. This legitimate use has become permanent from lack of other fuel, and it has extended to other kinds of generation of power, including marine transportation for shipments coastwise and to foreign countries.

A serious menace to the continued use of oil for fuel in California is the recent change in the character of the crude oils of that State. Many of the new pools yield oils suitable for refining and for the production of large quantities of gasoline and kerosene. Up to the beginning of 1913, about 30 per cent of the oils of California were refined and the rest was sold for fuel as crude or after very slight distillation of the lightest products. This practice changed materially during 1913, so that the proportion of crude oil used direct as fuel became reversed, and, although no accurate figures are available, 70 per cent is about the proportion of crude oil which was refined during that year before the heavier portions were sold for fuel. The result of this, however, will be not to decrease the use of oil for fuel but to change the method of its application, particularly to the internal combustion engine burning kerosene and heavier distillates.

Carefully collected statistics give the following results of the consumption of fuel oil by railroads in the United States from 1906 to 1913.

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Although the use of fuel oil extended to a greater number of miles of railroad, the quantity of oil consumed by these railroads decreased slightly and the total mileage made by oil-burning engines decreased in similar proportion, leaving the average number of miles made per barrel of oil consumed the same in 1913 as in 1912.

If it were possible to give a complete statement as to the tonnage moved per barrel, it would undoubtedly show an increase on account of the heavier trains moved, which is offset as to consumption of oil by the increased efficiency of new oil burners, arrangement of oil tanks, and increased skill developed by the firemen.

During 1913 three railroad companies discontinued the use of fuel oil and returned to coal, impelled not only by the advancing tendency of fuel-oil prices but by direct notification from refineries that continuation of contracts would be impracticable. The increase in demand for light products from crude oil has reduced the volume of residuum available for locomotive and other fuel use to a point approximating only 30 per cent of that obtained when gasoline was not in strong demand.

Consumption of fuel oil by the railroads of the United States, 1906–1913.

Year.	Length of line operated by the use of fuel oil.[a]	Quantity of fuel oil consumed by railroads.	Total mileage made by oil-burning engines.	Average number of miles per barrel of oil consumed.
	Miles.	*Barrels.*	*Miles.*	*Miles.*
1906		15,577,677		
1907	13,573	18,849,803	74,079,726	3.93
1908	15,474	16,870,882	64,279,509	3.81
1909	17,676	19,905,335	72,918,118	3.66
1910	22,709	23,817,346	89,107,883	3.74
1911	30,039	29,748,845	109,680,976	3.69
1912	28,451	33,605,598	121,393,228	3.61
1913	29,145	33,004,815	118,672,162	3.60

[a] Some of these lines also used coal.

The following are the names of the railroad companies which used fuel oil on their lines in 1913:

Arizona:
- Atchison, Topeka & Santa Fe Railway System.
- Pacific System (excluding Sonora Railway) of the Southern Pacific Co

Arkansas:
- Kansas City Southern Railway Co. (partly).
- St. Louis & San Francisco Railroad Co. and branches.

California:
- Atchison, Topeka & Santa Fe Railway System.
- Northwestern Pacific Railroad Co.
- Pacific System (excluding Sonora Railway) of the Southern Pacific Co.
- San Diego & Arizona Railway Co.
- San Diego & South Eastern Railway Co.
- San Pedro, Los Angeles & Salt Lake Railroad Co
- Tonopah & Tidewater Railroad.
- Western Pacific Railway Co.

Georgia:
- Central of Georgia Railway Co. (on Tybee district).

Idaho:
- Chicago, Milwaukee & St. Paul Railway Co.
- Idaho & Washington Northern Railroad.
- Oregon Short Line Railroad Co.
- Washington, Idaho & Montana Railway Co.

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Kansas:
Atchison, Topeka & Santa Fe Railway System.
Kansas City Southern Railway Co. (partly).
Rock Island Lines.[1]
St. Louis & San Francisco Railroad Co. and branches.
Louisiana:
Atchison, Topeka & Santa Fe Railway System.
Houston & Shreveport Railroad Co.
Iberia & Vermilion Railroad Co.
Kansas City Southern Railway Co.
Louisiana Western Railroad Co.
Morgan's Louisiana & Texas Railroad & Steamship Co.
New Orleans, Texas & Mexico Railroad Co.
Texas & Pacific Railway Co.
Missouri:
Kansas City Southern Railway Co. (partly).
St. Louis & San Francisco Railroad Co. and branches.
Montana:
Chicago, Milwaukee & St. Paul Railway Co. (west of Deer Lodge to the Idaho State line).
Oregon Short Line Railroad Co.
Nebraska:
Chicago & North Western Railway Co.
Nevada:
Atchison, Topeka & Santa Fe Railway System.
Bullfrog Goldfield Railroad.
Las Vegas & Tonopah Railroad Co.
San Pedro, Los Angeles & Salt Lake Railroad Co.
Tonopah & Goldfield Railroad Co.
Tonopah & Tidewater Railroad.
Western Pacific Railway Co.
New Mexico:
El Paso & Southwestern System.
Pacific System (excluding Sonora Railway) of the Southern Pacific Co.
New York:
Delaware & Hudson Co. (in the Adirondacks).
New York Central & Hudson River Railroad Co. (in the Adirondacks, including Old Forge and the Fulton Chain).
Oklahoma:
Atchison, Topeka & Santa Fe Railway System.
Kansas City Southern Railway Co. (partly).
Rock Island Lines.[1]
St. Louis & San Francisco Railroad Co. and branches.
Oregon:
Corvallis & Eastern Railroad Co.
Northern Pacific Railway Co.
Oregon-Washington Railroad & Navigation Co.
Pacific Railway & Navigation Co.
Spokane, Portland & Seattle Railway Co.
South Dakota:
Chicago & North Western Railway Co.
Texas:
Artesian Belt Railroad Co.
Atchison, Topeka & Santa Fe Railway System.
Galveston, Harrisburg & San Antonio Railway Co.
Galveston, Houston & Henderson Railroad Co.
Houston, East & West Texas Railway Co.
Houston & Texas Central Railroad Co.
International & Great Northern Railway Co.
Kansas City Southern Railway Co.
New Orleans, Texas & Mexico Railroad Co.
Rock Island Lines (including Chicago, Rock Island & Gulf Railway).[1]
St. Louis, Brownsville & Mexico Railway.
St. Louis & San Francisco Railroad Co. and branches.[2]

[1] Use of oil-burning locomotives discontinued after Apr. 1, 1913, except in switch engines.
[2] Use of oil-burning locomotives discontinued in May, 1913.

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Texas—Continued.
St. Louis, San Francisco & Texas Railway.[1]
San Antonio & Aransas Pass Railway Co.
Texas & Pacific Railway Co.
Trinity & Brazos Valley Railway Co.
Texas & New Orleans Railroad Co.
Utah:
San Pedro, Los Angeles & Salt Lake Railroad Co.
Washington:
Bellingham & Northern Railway Co.
Chicago, Milwaukee & St. Paul Railway Co.
Great Northern Railway Co.
Idaho & Washington Northern Railroad.
Northern Pacific Railway Co.
Oregon-Washington Railroad & Navigation Co.
Spokane, Portland & Seattle Railway Co.
Wyoming:
Chicago & North Western Railway Co.
Wyoming & Northwestern Railway.

UNITED STATES NAVY.

The policy of the United States is to use oil exclusively as a fuel in all new battleships and torpedo vessels. There are now built or building the following ships that use oil exclusively as a fuel: Four battleships, 41 destroyers, 50 submarines, 1 monitor, 3 tank ships, 3 tenders, 7 oil barges, and several tugs and small vessels.

The Navy now has the following oil-storage tanks complete: Boston, Mass., 50,000 barrels; Melville Station, R. I., 33,000 barrels; Norfolk, Va., 33,000 barrels; Charleston, S. C., 33,000 barrels; Key West, Fla., 33,000 barrels; Guantanamo, Cuba, 212,000 barrels; San Diego, Cal., 50,000 barrels; and Pearl Harbor, Hawaii, 235,000 barrels.

The naval appropriation act for the fiscal year carries $500,000 for additional fuel-oil storage at Melville, Norfolk, San Diego, Puget Sound, and San Francisco, and provides for the following new ships which will burn oil exclusively: Two battleships, 6 destroyers, 8 submarines.

For the fiscal year ended June 30, 1913, the Navy used something over 21,000,000 gallons of fuel oil.

During the year the Navy has had one representative on a commission to investigate and report upon the feasibility, desirability, and expense of the Government owning and operating a pipe line from the Mid-Continent field to the Gulf of Mexico for the purpose of supplying fuel oil for the Navy. The Navy needs an adequate, dependable supply of fuel oil that can be used at any time without the probabilities of increased cost due to forced buying in case of an emergency.

Tests have been carried out during the year at the fuel-oil testing plant at Philadelphia with a view to making the naval specifications for fuel oil less strict in order to get an oil at a cheaper price.

During 1913 a board was constituted in the Navy Department to determine a proper flash point for fuel oils to be used on battleships. The importance of this subject has been recognized by reports from various experts to foreign Governments, which have resulted in the

[1] Use of oil-burning locomotives discontinued after July 1, 1913.

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adoption of the following minimum flash points for fuel oils for naval purposes:

Minimum flash points adopted for fuel oils for naval use.

	° F.
United States	[a] 150
Great Britain	175
Germany	187
France	200
Russia	212
Italy	212
Austria	248

The board began its investigation by adopting the following assumptions before proceeding with the investigation:

(*a*) That oils having viscosities such that they must be heated in the bunkers must have such a flash point that no explosive or inflammable mixtures are formed therein.

(*b*) That it is undesirable and dangerous that oil should be heated anywhere—in bunkers or in firerooms—above the point where explosive or inflammable gases are given off.

(*c*) That the reliability of the flash cup in determining the point at which this condition of explosive mixture begins to exist should be checked in order that a guide may be established which may be known to be safe and positive.

The board then obtained large samples of oils which showed characteristics given in the accompanying table. These oils include the characteristics of practically all known fuel oils.

The first problem investigated by the board was to find the temperature at which various oils must be heated in the bunkers in order that the pumps may take more than the quantity for full-speed steaming conditions. With pumps such as used on battleships three grades of Mexican oils were used, those designated as 15.4°, 17.3°, and 11.7° gravity Baumé, the last representing the extreme of viscous oils on the market. The suction was taken from the 1,200-gallon submerged oil tanks with about an 8-foot lift from about 100 feet of 3-inch piping bushed down to 2½ inches at the pump. The following results were obtained:

Pumping capacity of pumps for different oils at varying temperatures.

Temperature (° F.).	Toltec, Mexican, 12° B., gallons per hour.	Mexican, 15.4° B., gallons per hour.	Mexican, 17.3° B., gallons per hour.
65	87	.....	417
73	120	226	.....
75	130	376	1,105
80	173	717	1,414
90	295	1,365	1,997
100	458	1,904	2,546
110	663	2,486	2,970
120	987	3,000	3,348
130	1,360	3,516	3,636
140	1,775	.....	.....
150	.....	4,190	4,063

The board estimated that the standard Blake pump used in this test, which conforms with the installation on board ship, requires that this pump should deliver 564 gallons an hour, in order to secure an adequate quantity for full power. This, then, is taken as the standard of comparison in determining the temperature to which oil must be heated in order that the suction pumps may supply an adequate quantity for full speed.

[a] Reduced from 175° by recommendation of this board.

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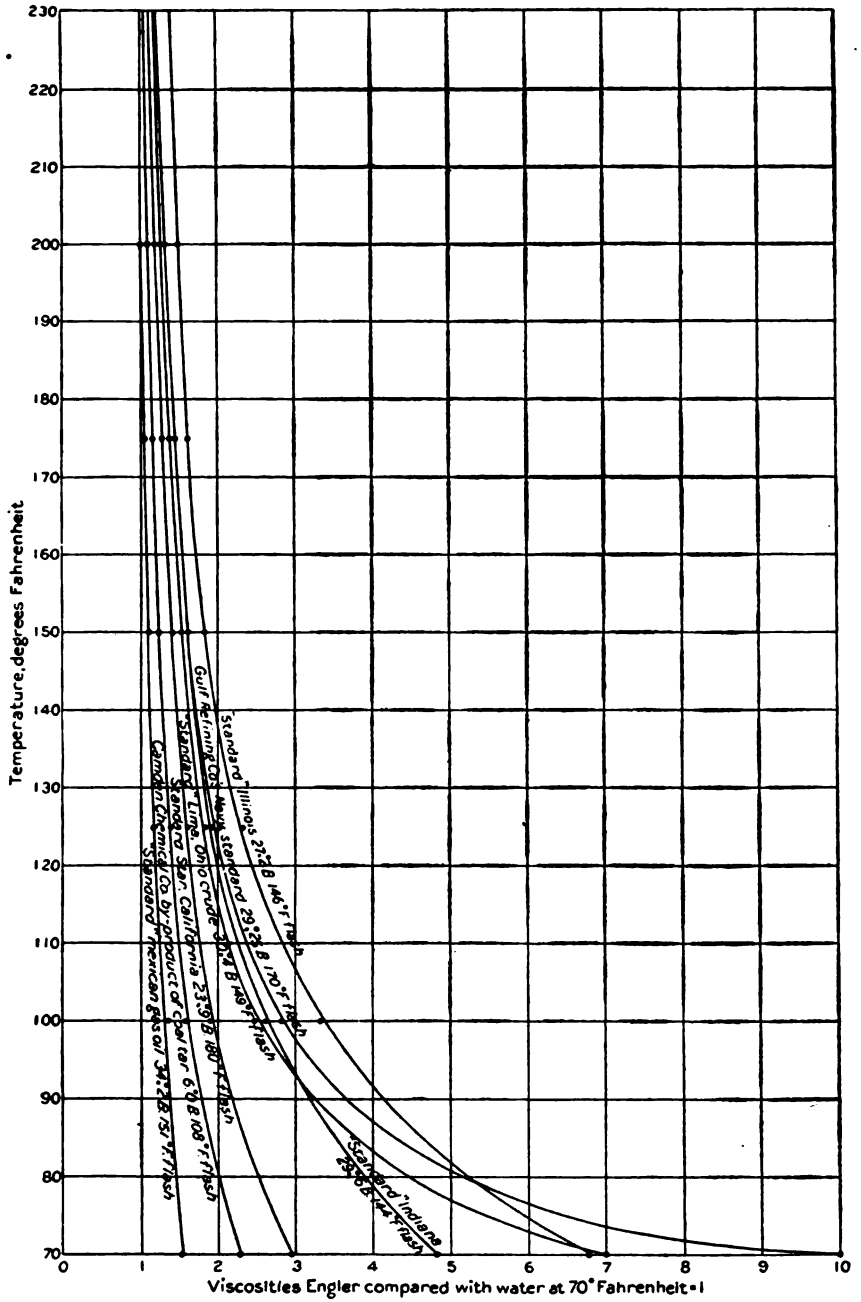

FIGURE 21.—Curves showing the relation of viscosity to temperature for various fuel oils.

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It will be seen from the curve of pumping capacity that the 17.3° Mexican oil must have a temperature of 67° F. or above in order that the pump may take an adequate supply for full speed; the Mexican 15.4°, a temperature of 77° F. or above; and the Toltec (Mexican) 12° B. must be heated to 105° F. This latter result is considered by the board as the limiting temperature. The board ascertained that it is the practice on the Southern Pacific steamers burning this oil to heat up to 115° or 120° F.

The next problem was to sample and analyze and attempt to ignite the gases given off in the bunkers at these temperatures, in order to ascertain the danger of such heating of oil in the bunkers. This investigation was carried out by A. G. Hulett and C. A. Burrell, of the Bureau of Mines. The investigation showed that no inflammable gas is formed under conditions similar to those in the bunkers of ships until the oil is heated to its flash point, and that the Abel Pennsky-Martin closed flash cup gives results which check with the results obtained in the tank. The experiment showed that the fuel oils in this experiment did not contain dissolved gas or vapor sufficient to form any explosive mixture until a temperature equivalent to flash point was reached. Examination of the air over the fuel oils in the bunkers of various battleships showed that this air did not contain more than an insignificant quantity of combustible vapor. Almost 0.9 per cent of combustible vapor must be present in a mixture of vapor and air to form an explosive mixture. The largest amount found was 0.04 per cent. The following conclusions were reached:

1. At the flash temperatures the vapors produced constitute about 1.0 to 1.25 per cent of the mixture of air and vapor. They consist principally of vapors of the liquid paraffins, hexane, and heptane.
2. On board ship these oils can be heated to within about 15° C. (59° F.), of their flash point before even a noticeable halo or partial burning occurs should they be accidentally inflamed.
3. The flash points shown herein are a good indication of the temperatures to which the oils can be heated before an explosion of the released vapors can occur.

The board also conducted actual tests of each kind of oil, using a type of Navy boiler, Navy standard burner, etc., to ascertain the temperature to which each type of oil must be heated in order to secure smokeless combustion.

The various oils were given an evaporative test in a Navy boiler, using the bureau type burners, pumps, etc. The record of these tests are in the files of the Bureau of Steam Engineering. All these oils were easily burned without smoke, and the temperature of the oil was noted at the oil heater. It developed that the temperatures were such in general as to indicate that all oils of whatever character must be heated to a viscosity of 8 Engler in order to burn smokelessly without undue excess of air. As a point of interest, any increase of heating in reducing the viscosity below 8 Engler is not accompanied by increase in evaporative efficiency. On all the tests the temperature of the oil was dropped for a few minutes at various times below that corresponding to 8 Engler, while keeping the oil pressure, draft, etc., steady. In every case where the temperature was dropped below the critical temperature corresponding to 8 Engler the smoke increased in density and volume; and as the temperature was again brought up the smoke disappeared at the same critical temperature. It thus appears that 8 Engler for smokelessness is well established for the present oil-burning apparatus on board United States naval vessels. (See Pl. III and fig. 21.)

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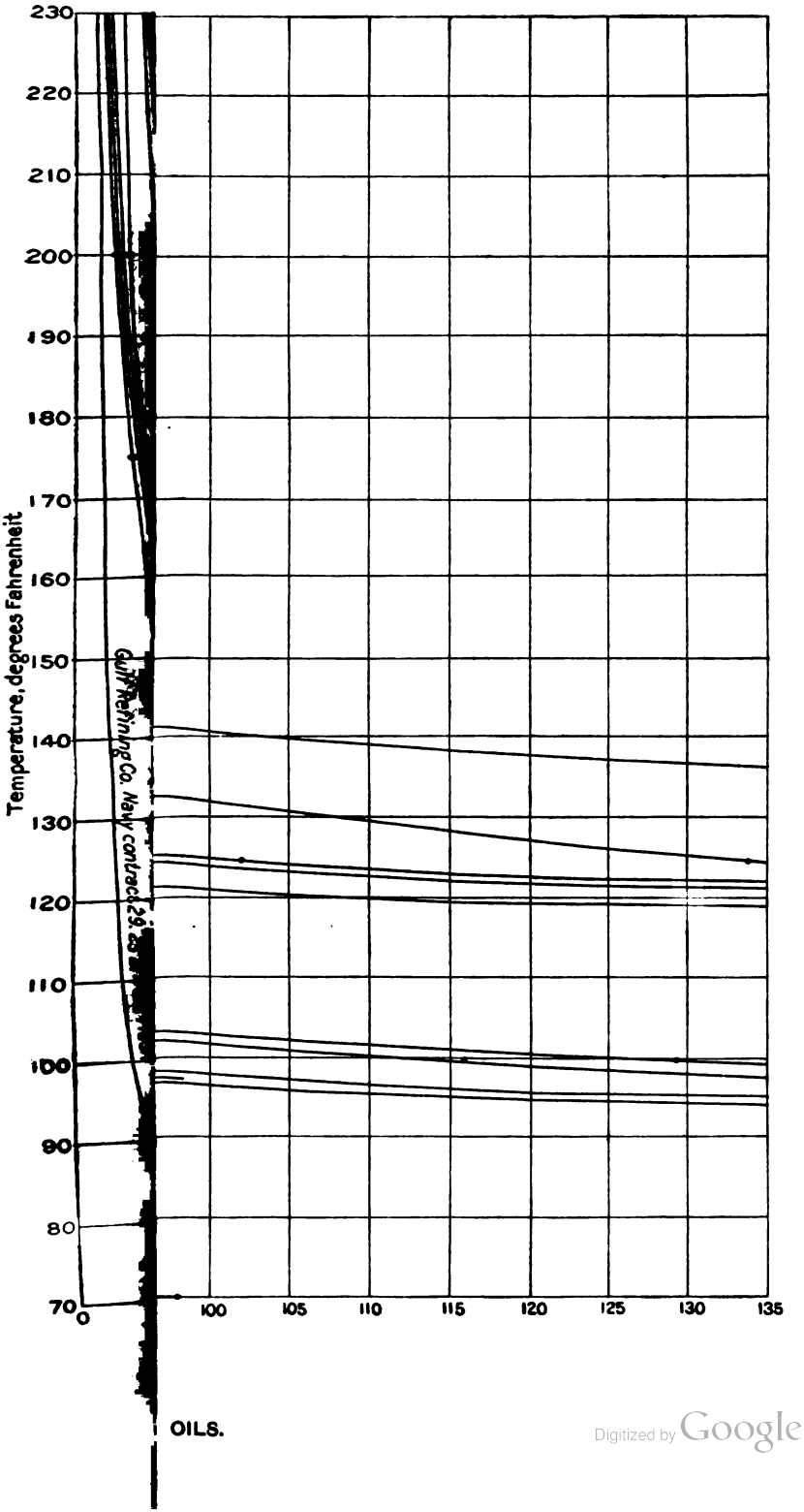

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In connection with the work of the board the Philadelphia Navy Yard was instructed to conduct experiments for such oils as might be available to determine the permissible content of sulphur and the extent of the corrosion which may occur with oils containing various sulphur contents. Various test pieces of steel, both dull and bright, were placed in oils of five different grades as to sulphur content, and the tanks were heated to 120° F. and maintained at that temperature for a month. The second set of tanks was maintained at 100° F., and the third set was kept at the ordinary temperature. At the end of this period a careful inspection of the different test pieces was made. No conclusion could be drawn with reference to the corrosion due to the oils having a high sulphur content. Some of the greatest losses in weight were noticed in the test pieces immersed in the low sulphur content oils, and in one case one of the high sulphur content oils lost practically nothing in weight. The experiments have not been concluded, but as far as made show that the loss of weight is not directly dependent upon the sulphur content.

The general conclusions of the board concerning the proper flash point for fuel oils are:

1. It is not necessary to heat any known fuel oil now found on the market to a temperature above 105° F. in order to obtain free flow and adequate suction with the type of pumps, piping, etc., installed on board naval vessels.
2. No inflammable or explosive mixtures are formed when a tank of oil is heated to this temperature by a steam coil, nor are they formed at any temperature below the flash point.
3. The minimum of 150° F. flash-point, as obtained with the Abel or Pennsky-Martin's cup, is safe, and further has an adequate margin of safety.
4. In order to attain smokeless burning with the present oil-burning installations on board ship, the temperature of the oil at the oil heater must be that corresponding to 8 Engler.

The work of the board, if applied to the framing of specifications for fuel oil for the Navy, would result as follows:

1. Fuel oil shall be a hydrocarbon oil, free from grit, acid, and free from fibrous and other foreign matter likely to clog or injure the burners.
2. The flash point shall not be below 150° F. (Abel or Pennsky-Martin's closed cup), nor shall it be lower than that temperature at which the oil has a viscosity of 8 by the Engler scale (water at 70° F.=1).
3. Viscosity: Not greater than 200 Engler at 100° F.[1]
4. Water and sediment shall not exceed 1 per cent; if in excess of this, the excess to be subtracted from the volume, or the oil may be rejected.

As recently explained by Mr. Winston Churchill,[2] first lord of the Admiralty, the British Admiralty has in stock, safely stored in England, considerably more than three years' consumption of fuel for their very large oil-burning fleet. The Admiralty keeps, either purchased or stored in the country or else in view under definite war contracts or other effective arrangements, sufficient oil to enable it to conduct a whole year's war, and arrangements are complete for increasing this reserve with the increase of the fleet.

In regard to the propriety of the use of oil as fuel in the British Navy, Mr. Winston Churchill states:

1. The advantages to be derived from the use of oil fuel, and the imperative necessity for such use if the fleet is to be maintained in a condition of the highest attainable efficiency, are conclusively established by the commissioners' first interim report.

[1] The limiting viscosity of 200 Engler is suggested because it developed during the tests that the present type of oil heater installed on board ship will not heat the heaviest Mexican and California oils to a sufficient degree to allow smokeless combustion at full power. When the type of oil heater is improved, the viscosity clause can be eliminated.

[2] Petroleum Rev., March, 1914.

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2. The commissioners are of opinion that the oil resources of the world are amply adequate to meet the requirements of the fleet if suitable measures are taken to secure supplies.

3. Large reserves should be accumulated in this country and at certain other storage centers in British territory. The extent of these reserves should bear a prescribed relation to the consumption under peace requirements, and this will give a definite basis.

PETROLEUM OPERATORS' STATISTICS.

As stated on a previous page, the statistics of petroleum production are collected by two different systems, and the resulting totals represent a combination of the data obtained by both systems. It is interesting also to publish the totals of the statistics obtained from the statistical cards returned by the producers only. If every operator furnished the statement requested the results would represent the exact and complete production of petroleum in the United States, whereas the pipe-line runs alone never can amount to the complete production and always require the addition of the railroad shipments and the shipments made directly from wells to refineries, the collection of statistics for which involves considerable correspondence with many operators.

The following tables of the operators' statistics alone are therefore an interesting index of the degree to which the petroleum operators recognize the advantage of cooperating with the United States Geological Survey by promptly furnishing their individual statements. The statistics for some of the States are within less than 2 per cent of the actual production of those States, as shown by the pipe-line returns plus the additional figures from railroads and other sources. To most petroleum statisticians the expression "pipe-line runs" is synonymous with "total production," whereas the production of oil shown by the pipe-line returns is always less than the total production, because considerable oil is produced which never gets into pipe lines. In Illinois, for example, the quantity of oil shown by the pipe-line runs, published monthly, differs from the actual production by 8 per cent, which is much more than the difference—1.4 per cent—between the quantity reported from producers and the total actual production. In Oklahoma the corresponding pipe-line runs are 16 per cent less than the total production, and the reported production by the operators is 8.5 per cent less than the total. In Pennsylvania this "pipe-line" total is 23 per cent less than the real production, whereas the total from the reporting operators is 10.8 per cent less. This is what might be expected in Pennsylvania, because the total of barrels is made up of statements from thousands of small producers, including part-interest owners, hundreds of whom produce less than 1,000 barrels each year. In fact, it was emphatically stated by the producers themselves that the collection of the oil statistics from the producers would be impossible, and Pennsylvania was cited as an obvious example of this impossibility. The encouraging result from Pennsylvania was largely due to the cooperation of Richard R. Hice, State geologist of Pennsylvania.

As already explained, the statistics for California, Colorado, and Wyoming have always been collected from the producers, and these are presented under the detailed statement of those particular States.

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Production and value of petroleum, well records, and acreage for the United States in 1912 and 1913, by States, from statistics furnished by producers.

1912.

State.	Production (in barrels).			Value.	Average price per barrel.	Wells.					Average daily production (in barrels) per well.	Acreage.		
	Placed to credit of—		Total.			Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.		Fee.	Lease.	Total.
	Producer.	Landowner.					Oil.	Dry.						
Alabama								2				80	9,000	9,080
Alaska			(a)	(a)		3	2			5		160	9,500	9,660
Arizona								1				160		160
Arkansas								5				80	89,800	89,880
California	83,916,130	3,356,463	b87,272,593	b$39,624,501	$0.454	5,947	776	71	402	6,321	37.8	334,902	208,926	543,828
Colorado	204,852	1,200	206,052	199,661	.968	120	15	13	23	112	5.0	9,404	11,365	20,769
Georgia								1					1,500	1,500
Illinois	23,891,074	4,287,014	28,178,088	24,403,811	.866	12,753	992	208	507	13,238	5.8	3,161	255,843	259,004
Indiana	736,233	114,364	850,597	793,891	.933	5,127	82	17	1,038	4,171	.6	(c)	(c)	(c)
Kansas	1,117,325	132,184	1,249,509	832,171	.665	1,757	279	41	224	1,812	1.9	18,458	119,274	137,732
Kentucky	348,714	43,376	392,090	331,738	.846	988	96	56	148	936	1.1	(c)	(c)	(c)
Louisiana	9,140,524	1,611,172	10,751,696	7,970,977	.741	555	315	91	90	780	37.7	29,345	221,034	250,379
Michigan			(d)	(d)		44	6	2		50		(c)	(c)	(c)
Missouri														
New Mexico								1				800	1,920	2,720
New York	812,334	65,193	877,527	1,346,448	1.534	10,625	248	6	357	10,516	.2	(c)	(c)	(c)
Ohio	6,709,770	1,011,632	e 7,721,402	e10,417,921	1.349	31,337	1,485	297	2,083	30,739	.7	(c)	(c)	(c)
Oklahoma	38,061,084	5,447,496	43,508,580	29,489,162	.678	15,698	3,668	440	651	18,715	6.4	43,731	1,383,705	1,427,436
Oregon								1				7,000	700	7,700
Pennsylvania	6,348,298	688,293	7,036,591	11,407,465	1.621	52,745	2,196	195	1,396	53,545	.36	(c)	(c)	(c)
Tennessee								1				684	27,500	28,184
Texas	9,776,241	1,199,738	10,975,979	8,100,329	.738	2,473	757	284	246	2,984	10.1	51,089	1,186,570	1,237,659
Utah			(f)			17		1	4	13		13,717	1,160	14,877
Wyoming	1,225,081	347,225	1,572,306	798,470	.507	160	59	24	30	189	22.7	20,144	44,666	64,810
West Virginia	10,160,301	1,424,285	11,584,586	18,785,748	1.602	13,014	1,327	140	616	13,725	2.3	310,799	1,636,611	1,947,410
Total	192,447,961	19,729,635	212,177,596	154,502,293	.728	153,363	12,303	1,898	7,815	157,851	3.7			

a Included in California.
b Includes Alaska.
c Data for 1912 not complete.
d Included in Ohio.
e Includes production of Michigan.
f No production.

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Production and value of petroleum, well records, and acreage for the United States in 1912 and 1913, by States, from statistics furnished by producers—Continued.

1913.

State.	Production (in barrels).			Value.	Average price per barrel.	Wells.					Average daily production (in barrels) per well.	Acreage.		
	Placed to credit of—		Total.			Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.		Fee.	Lease.	Total.
	Producer.	Landowner.					Oil.	Dry.						
Alaska			(a)	(a)		5	2			7		160	9,500	9,660
Arkansas								5					28,381	28,381
California	93,692,611	4,095,914	97,788,525	$45,709,400	$0.467	6,321	789	67	293	6,817	39.3	293,332	209,611	502,943
Colorado	187,902	897	188,799	174,779	.926	112	8	13	27	93	5.6	9,733	5,605	15,338
Illinois	19,896,114	3,669,105	23,565,219	31,038,378	1.317	13,238	1,356	187	494	14,100	4.6	3,368	244,327	247,695
Indiana	758,603	115,650	874,253	1,150,875	1.316	4,171	202	37	559	3,814	.6	7,570	99,705	107,275
Kansas	1,994,108	248,725	2,242,833	2,123,586	.947	1,812	1,336	87	94	3,054	2.0	20,566	182,438	203,004
Kentucky	428,510	51,072	479,582	584,269	1.218	936	112	51	80	968	1.3	27,579	141,479	169,058
Louisiana	10,368,537	2,008,263	12,376,800	11,897,422	.960	780	369	64	149	1,000	33.9	59,151	410,552	469,703
Michigan			(a)	(a)		27	4	1	5	26		15	3,240	3,255
Mississippi								2					1,000	1,000
Missouri			(a)	(a)		23		1		23			16,292	16,292
New Mexico			(a)	(a)		1	1	2		2			2,860	2,860
New York	807,969	62,386	870,355	2,116,679	2.432	10,516	393	17	228	10,681	.2	44,261	85,571	129,832
Ohio	6,908,361	1,039,546	7,947,907	14,951,993	1.881	30,739	2,165	335	1,957	30,947	.7	64,733	845,240	909,973
Oklahoma	50,909,222	7,245,483	58,154,705	54,971,500	.945	18,715	6,111	669	741	24,085	6.6	36,414	1,486,417	1,522,831
Pennsylvania	6,443,173	658,694	7,101,867	17,789,287	2.505	53,545	b 3,538	318	2,006	55,077	.35	315,896	767,037	1,082,933
Tennessee								1						
Texas	13,065,046	1,652,388	14,717,434	14,216,115	.966	2,984	877	299	424	3,437	11.7	61,388	628,703	690,091
Utah			(c)	(c)		13		9	4	9		23,197		23,197
Washington							1			1				
West Virginia	9,770 887	1 420,927	11,191,814	27,935,262	2.496	13,725	1,320	180	501	14,544	2.1	66,520	1,878,599	1,945,119
Wyoming	1,608,120	798,402	2,406,522	1,187,232	.493	189	34	16	25	198	33.3	18,220	35,230	53,450
Other States	10,813	30	d 10,843	d 19,263	1.777									
Total	216,849,976	23,067,482	239,917,458	225,866,040	.941	157,851	18,618	2,361	7,587	168,882	3.8	1,052,103	7,061,787	8,133,890

a Included in "Other States."
b Includes many wells previously abandoned and in 1913 cleaned out and made productive on account of increased price during the year.
c No production.
d Includes Alaska, Michigan, Missouri, and New Mexico.

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The following tables give the well records of the petroleum industry in 1912 and 1913 for the respective States by counties:

Petroleum well record in 1912 and 1913, by counties.

NEW YORK.

County.	Productive Jan. 1.	1912				1913						
		Completed.		Abandoned.	Productive Dec. 31.	Completed.		Abandoned.	Productive Dec. 31.	Acreage.		
		Oil.	Dry.			Oil.	Dry.			Fee.	Lease.	Total.
Allegany	7,620	175	6	280	7,515	290	12	148	7,657	27,446	44,799	72,245
Cattaraugus	2,787	61	.....	66	2,782	97	5	72	2,807	15,285	39,768	55,053
Steuben	218	12	.....	11	219	6	.....	8	217	1,530	1,004	2,534
Total	10,625	248	6	357	10,516	393	17	228	10,681	44,261	85,571	129,832

PENNSYLVANIA.

Allegheny	1,688	50	19	74	1,664	62	18	46	1,680	2,957	68,777	71,734
Armstrong	179	8	.....	17	170	25	3	27	168	2,411	3,174	5,585
Beaver	593	33	11	17	609	29	14	48	590	2,059	12,321	14,380
Butler	5,116	258	51	106	5,268	434	80	233	5,469	21,229	59,626	80,855
Clarion	1,792	39	7	82	1,749	138	25	136	1,751	11,768	21,414	33,182
Crawford	616	24	.....	43	597	47	4	76	568	983	4,909	5,892
Elk	1,116	10	2	8	1,118	36	2	4	1,150	12,169	55,433	67,602
Forest	1,633	39	15	60	1,612	145	17	95	1,662	36,864	40,988	77,852
Greene	484	31	19	19	496	34	28	23	507	1,327	78,494	79,821
Jefferson	131	5	6	1	135	7	7	.....	142	9,540	32,717	42,257
Lawrence	68	552	5	3	617	302	6	1	918	97	15,470	15,567
McKean	15,055	288	12	373	14,970	613	14	528	15,055	91,394	120,475	211,869
Mercer	266	11	.....	1	276	10	.....	11	275	230	2,995	3,225
Potter	85	.....	.....	7	78	14	.....	.....	92	36,337	8,861	45,198
Tioga	26	.....	.....	19	7	.....	.....	.....	7	.....	247	247
Venango	15,199	634	27	281	15,552	1,320	72	432	16,440	49,548	65,571	115,119
Warren	6,906	189	16	196	6,899	290	12	248	6,941	34,811	43,585	78,396
Washington	1,792	25	5	89	1,728	32	16	98	1,662	2,172	131,480	133,652
Total	52,745	2,196	195	1,396	53,545	a3,538	318	2,006	55,077	315,896	767,087	1,082,983

WEST VIRGINIA.

Braxton	1	.....	1	.....	1	3	.....	1	3	.....	56,772	56,772
Brooke	326	5	1	58	273	9	4	19	263	824	6,310	7,134
Cabell	23	1	.....	.....	24	1	2	2	23	.....	5,973	5,973
Calhoun	274	37	5	21	290	24	5	11	303	73	17,440	17,513
Clay	3	11	3	2	12	18	1	4	26	234	58,586	58,820
Doddridge	554	19	5	3	570	39	16	15	594	2,324	57,527	59,851
Gilmer	83	4	.....	3	84	9	3	6	87	646	12,852	13,498
Greenbrier	.....	.....	.....	.....	.....	.....	1	.....	1	.....	.....	.....
Hancock	300	52	1	4	348	16	3	36	328	1,371	5,100	6,471
Harrison	1,148	58	8	50	1,156	85	9	27	1,214	4,691	76,257	80,948
Jackson	.....	.....	.....	.....	.....	1	.....	.....	1	.....	90,330	90,330
Kanawha	5	409	17	4	410	184	11	22	572	733	323,056	323,789
Lewis	224	34	6	3	255	17	4	1	271	6,835	82,571	89,406
Lincoln	493	68	.....	2	559	76	1	3	632	1,182	249,644	250,826
Logan	2	.....	.....	1	1	.....	.....	1	1	.....	33,591	33,591
Marion	640	19	2	15	644	46	5	6	684	1,307	51,910	53,217
Marshall	167	9	.....	41	135	3	1	4	134	250	6,741	6,991
Mason	.....	1	2	.....	1	2	4	.....	8	.....	10,225	10,225
Monongalia	677	20	1	13	684	34	4	14	704	15,498	80,503	96,001
Ohio	4	.....	.....	2	2	5	.....	.....	7	20	9,005	9,025
Pleasants	1,613	69	13	166	1,516	156	19	79	1,593	1,441	35,406	36,847
Putnam	.....	.....	2	.....	.....	2	2	.....	2	.....	3,972	3,972
Ritchie	1,801	110	18	64	1,847	164	30	94	1,917	6,882	122,623	129,505
Roane	714	122	10	10	826	216	18	5	1,037	4,462	257,330	261,792
Tyler	1,577	40	18	64	1,553	43	11	38	1,558	5,039	48,753	53,792
Upshur	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wayne	2	1	.....	2	1	2	1	1	2	4,400	63,075	64,475
Wetzel	1,196	56	3	72	1,180	23	12	20	1,183	2,259	88,829	91,088
Wirt	431	56	2	10	477	57	2	41	493	4,578	9,600	14,178
Wood	756	126	21	6	876	85	11	51	910	1,471	14,118	15,589
Total	13,014	1,327	140	616	13,725	1,320	180	501	14,544	66,520	1,878,599	1,945,119

a Includes many wells previously abandoned and in 1913 cleaned out and made productive on account of increased price during the year.

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Petroleum well record in 1912 and 1913, by counties—Continued.

KENTUCKY.

County.	Productive Jan. 1.	1912			Productive Dec. 31.	1913						
		Completed.		Abandoned.		Completed.		Abandoned.	Productive Dec. 31.	Acreage.		
		Oil.	Dry.			Oil.	Dry.			Fee.	Lease.	Total.
Allen	.....	6	.....	.....	6	6	2	.....	12	.....	4,232	4,232
Barren	7	.....	.....	.....	7	3	2	.....	10	31	1,514	1,545
Bath	91	.....	.....	1	90	.....	.....	.....	90	.....	800	800
Boyd	.....	.....	19	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cumberland	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Floyd	19	3	.....	2	20	.....	1	.....	20	.....	6,175	6,175
Hancock	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....
Knott	2	.....	.....	.....	2	.....	.....	.....	2	.....	568	568
Knox	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Lawrence	10	14	6	6	18	11	2	2	27	1,500	21,325	22,825
Logan	5	3	.....	.....	8	.....	1	2	6	.....	8,000	8,000
Martin	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	3,600	3,600
Morgan	.....	4	.....	.....	4	30	10	1	33	2,000	2,394	4,394
Ohio	.....	3	.....	1	2	2	1	.....	4	.....	6,200	6,200
Rowan	35	.....	.....	.....	35	.....	.....	.....	35	.....	350	350
Shelby	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Wayne	688	53	28	126	615	44	21	62	597	24,048	67,821	91,869
Wolfe	131	10	1	12	129	16	7	13	132	.....	18,500	18,500
Total	988	96	56	148	936	112	51	80	968	27,579	141,479	169,058

OHIO.

Allen	1,803	31	.....	255	1,579	105	7	115	1,569	2,193	26,622	28,815
Athens	121	18	4	14	125	11	2	12	124	1,270	10,551	11,821
Auglaize	561	13	.....	44	530	23	1	23	530	1,458	2,229	3,687
Belmont	185	8	2	41	152	31	4	1	182	527	25,185	25,712
Carroll	43	6	.....	2	47	16	.....	3	60	329	8,790	9,119
Clermont	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....
Columbiana	291	21	10	46	266	62	10	7	321	116	6,155	6,271
Coshocton	17	2	5	.....	19	15	5	4	30	.....	52,040	52,040
Cuyahoga	.....	.....	.....	.....	.....	1	.....	.....	1	.....	.....	.....
Erie	.....	.....	.....	.....	.....	1	.....	.....	1	.....	325	325
Fairfield	242	50	1	12	280	32	6	19	293	234	18,183	18,417
Guernsey	10	4	.....	.....	14	11	.....	7	18	.....	785	785
Hancock	3,293	70	2	137	3,226	156	12	225	3,157	2,099	33,222	35,321
Hardin	.....	2	1	.....	2	1	.....	.....	3	326	.....	326
Harrison	862	20	13	136	746	61	5	91	716	3,530	10,159	13,689
Hocking	20	79	12	2	97	57	11	8	146	3,110	90,956	94,066
Holmes	28	3	.....	.....	31	3	.....	.....	34	140	6,571	6,711
Jackson	14	.....	.....	14	.....	1	.....	.....	1	.....	2,000	2,000
Jefferson	426	31	16	22	435	59	39	35	459	2,805	13,336	16,141
Knox	6	3	.....	.....	9	2	7	1	10	192	23,003	23,195
Lake	.....	1	.....	.....	1	.....	.....	.....	1	.....	1,000	1,000
Lawrence	.....	3	2	.....	3	.....	.....	.....	3	.....	1,868	1,868
Licking	1	23	10	.....	24	29	3	.....	53	.....	36,491	36,491
Logan	.....	3	2	.....	3	3	1	.....	6	.....	10,000	10,000
Lorain	9	.....	5	1	8	.....	.....	.....	8	.....	.....	.....
Lucas	530	20	2	65	485	34	1	44	475	1,993	4,687	6,680
Mahoning	.....	.....	.....	.....	.....	1	.....	.....	1	.....	3,900	3,900
Marion	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Medina	3	.....	.....	.....	3	.....	.....	.....	3	.....	84,359	84,359
Meigs	.....	1	1	.....	1	.....	.....	1	.....	.....	2,291	2,291
Mercer	702	11	.....	57	656	96	5	50	702	1,699	12,301	14,000
Monroe	2,587	118	38	72	2,633	85	18	185	2,533	6,431	62,875	69,306
Morgan	803	141	52	69	875	113	35	29	959	1,079	8,995	10,074
Muskingum	162	8	2	8	162	19	4	3	178	320	15,967	16,287
Noble	424	59	16	36	447	82	10	34	495	1,452	9,998	11,450
Ottawa	508	21	2	49	480	12	.....	55	437	2,376	6,897	9,273
Perry	320	212	17	33	499	170	25	36	633	2,345	78,394	80,739
Richland	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Sandusky	4,095	95	5	179	4,011	172	3	75	4,108	6,814	37,412	44,226
Seneca	672	20	4	55	637	35	3	46	626	1,700	5,049	6,749
Shelby	22	.....	.....	3	19	.....	.....	4	15	.....	200	200
Stark	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Summit	.....	.....	1	.....	.....	.....	1	.....	.....	76	.....	76
Trumbull	16	10	1	11	15	.....	.....	.....	15	728	210	938
Van Wert	842	20	4	132	730	34	6	73	691	1,006	14,586	15,592
Vinton	15	.....	.....	9	6	.....	.....	.....	6	60	3,501	3,561
Washington	3,878	176	56	321	3,733	349	55	287	3,795	4,940	46,356	51,296
Wayne	.....	11	5	.....	11	24	7	1	34	.....	10,570	10,570
Wood	7,719	168	1	258	7,629	258	46	477	7,410	12,495	54,921	67,416
Wyandot	107	3	3	.....	110	1	.....	6	105	890	2,300	3,190
Total	31,337	1,485	297	2,083	30,739	2,165	335	1,957	30,947	64,733	845,240	909,973

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Petroleum well record in 1912 and 1913, by counties—Continued.

INDIANA.

County.	Productive Jan. 1.	1912				1913						
		Completed.		Abandoned.	Productive Dec. 31.	Completed.		Abandoned.	Productive Dec. 31.	Acreage.		
		Oil.	Dry.			Oil.	Dry.			Fee.	Lease.	Total.
Adams	729	18	.....	196	551	10	.....	58	503	1,570	9,932	11,502
Blackford	239	4	.....	59	184	5	2	21	168	45	5,069	5,114
Daviess	.....	1	1	.....	1	2	.....	.....	3	.....	3,500	3,500
Delaware	164	16	3	52	128	40	3	26	142	610	7,206	7,816
Gibson	115	3	1	4	114	18	.....	.....	132	1	5,038	5,039
Grant	850	.....	.....	238	612	1	.....	97	516	200	10,637	10,837
Greene	.....	.....	.....	.....	.....	2	2	.....	6	.....	799	799
Hamilton	.....	.....	.....	.....	.....	1	.....	.....	1	.....	1,200	1,200
Harrison	.....	3	2	.....	3	.....	2	.....	3	.....	10,000	10,000
Huntington	492	.....	.....	70	422	4	.....	68	358	216	5,411	5,627
Jay	912	17	3	99	830	26	3	105	751	3,802	12,894	16,696
Knox	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Miami	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Montgomery	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pike	158	5	3	15	148	9	5	8	149	40	1,287	1,327
Porter	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Randolph	39	5	.....	.....	44	8	.....	.....	52	.....	8,600	8,600
Sullivan	6	2	.....	.....	8	70	17	.....	78	122	8,299	8,421
Vigo	8	1	.....	.....	9	.....	.....	.....	9	.....	179	179
Wayne	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wells	1,413	5	1	305	1,113	6	1	176	943	964	9,654	10,618
Total	5,127	82	17	1,088	4,171	202	37	559	3,814	7,570	99,705	107,275

ILLINOIS.

1912.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Bond	.....	.....	1	.....	.....	.....	6,315	6,315
Clark	2,254	62	7	90	2,226	1,260	23,865	25,125
Clinton	110	39	6	15	134	.....	4,598	4,598
Coles	54	10	11	.....	64	.....	630	630
Crawford	6,853	263	104	274	6,842	827	83,595	84,422
Cumberland	662	27	10	27	662	13	5,796	5,809
Edgar	6	.....	.....	.....	6	470	80	550
Jasper	.....	4	.....	.....	4	.....	651	651
Jackson	.....	.....	3	.....	.....	.....	.....	.....
Lawrence	2,769	543	53	92	3,220	591	63,786	64,377
Macoupin	1	3	4	.....	4	.....	3,280	3,280
Madison	1	1	.....	.....	2	.....	8,758	8,758
Marion	40	28	1	6	62	.....	19,688	19,688
Montgomery	.....	.....	2	.....	.....	.....	18,165	18,165
Perry	.....	.....	2	.....	.....	.....	12,656	12,656
Randolph	3	3	2	3	3	.....	600	600
Wabash	.....	9	2	.....	9	.....	3,380	3,380
Total	12,753	992	208	507	13,238	3,161	255,843	259,004

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Petroleum-well record in 1912 and 1913, by counties—Continued.

ILLINOIS—Continued.

1913.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Clark	2,226	104	14	125	2,205	948	25,487	26,435
Clinton	134	15	.....	1	148	.....	36,120	36,120
Coles	64	5	.....	.....	69	56	740	796
Crawford	6,842	612	95	150	2,304	901	77,722	78,623
Cumberland	662	20	2	46	636	.....	5,725	5,725
Douglas	.....	.....	1	.....	.....	.....	.....	.....
Edgar	6	3	2	.....	9	955	.....	955
Edwards	.....	.....	2	.....	.....	.....	.....	.....
Fulton	.....	.....	1	.....	.....	.....	.....	.....
Jackson	.....	.....	2	.....	.....	.....	.....	.....
Jasper	4	.....	2	1	3	.....	150	150
Jefferson	.....	.....	1	.....	.....	.....	2,000	2,000
Lawrence	3,220	547	56	168	3,599	166	60,715	60,881
Macoupin	4	2	4	.....	6	.....	4,780	4,780
Madison	2	.....	.....	.....	2	342	.....	342
Marion	62	35	.....	.....	97	.....	19,278	19,278
Morgan	.....	3	.....	.....	3	.....	390	390
Perry	.....	.....	1	.....	.....	.....	.....	.....
Randolph	3	.....	.....	3	.....	.....	460	460
St. Clair	.....	.....	1	.....	.....	.....	.....	.....
Wabash	9	10	1	.....	19	.....	2,760	2,760
Washington	.....	.....	1	.....	.....	.....	.....	.....
White	.....	.....	1	.....	.....	.....	8,000	8,000
Total	13,238	1,356	187	494	14,100	3,368	244,327	247,695

KANSAS.

1912.

Allen	170	34	14	32	172	1,452	7,913	9,365
Chautauqua	766	106	19	61	811	10,600	47,982	58,582
Coffey	2	.....	.....	.....	2	.....	398	398
Elk	4	2	.....	.....	6	.....	150	150
Franklin	26	.....	.....	14	12	.....	77	77
Labette	1	.....	.....	.....	1	.....	.....	.....
Miami	24	3	.....	.....	27	30	388	418
Montgomery	411	101	2	68	444	3,548	51,684	55,232
Neosho	183	24	5	39	168	1,778	3,860	5,638
Wilson	170	9	1	10	169	1,050	6,822	7,872
Total	1,757	279	41	224	1,812	18,458	119,274	137,732

1913.

Allen	172	142	9	5	309	1,126	13,117	14,243
Chautauqua	811	292	27	27	1,076	12,459	49,754	62,213
Cowley	.....	.....	2	.....	.....	.....	10,622	10,622
Coffey	2	1	.....	2	1	.....	158	158
Elk	6	.....	.....	.....	6	.....	160	160
Franklin	12	47	2	.....	59	.....	1,137	1,137
Greenwood	.....	1	.....	.....	1	.....	2,107	2,107
Labette	1	.....	2	.....	1	60	3,000	3,060
Miami	27	15	4	14	28	510	6,733	7,243
Montgomery	444	558	25	35	967	5,647	55,203	60,850
Neosho	168	244	15	7	405	724	24,823	25,547
Wilson	169	33	.....	4	198	40	15,624	15,664
Woodson	.....	3	1	.....	3	.....	.....	.....
Total	1,812	1,336	87	94	3,054	20,566	182,438	208,004

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Petroleum well record in 1912 and 1913, by counties—Continued.

OKLAHOMA.

1912.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Canadian			2			300		300
Carter	42	6	2		48	1,860	4,594	6,454
Cherokee			1				200	200
Cleveland			2				560	560
Coal			1				4,230	4,230
Comanche	3	2	3		5		20,580	20,580
Creek	1,784	238	39	43	1,979	6,547	176,252	182,799
Greer			1					
Haskell			1				1,500	1,500
Jefferson			3			5,000	14,500	19,500
Kay	4	35	10	4	35		51,456	51,456
Kiowa	5	6	2		11		6,640	6,640
Le Flore			1				10,000	10,000
Logan			1					
McIntosh			1				3,010	3,010
Marshall	3				3		3,594	3,594
Muskogee	285	36	6	18	303	684	15,248	15,932
Noble			1				5,000	5,000
Nowata	5,077	950	29	122	5,905	7,477	95,441	102,918
Okmulgee	244	189	52	37	396	3,992	111,649	115,641
Osage	1,593	366	45	91	1,868	1,400	520,754	522,154
Pawnee	317	133	27	59	391	400	42,819	43,219
Pittsburg			1				7,134	7,134
Rogers	1,763	103	12	161	1,705	1,390	23,438	24,828
Sequoyah			1				2,000	2,000
Tillman			1				10,500	10,500
Tulsa	1,306	643	70	32	1,917	7,683	105,568	113,251
Wagoner		6	4		6		4,796	4,796
Washington	3,272	955	121	84	4,143	6,998	141,242	148,240
Total	15,698	3,668	440	651	18,715	43,731	1,383,705	1,427,436

1913.

Atoka			1				1,052	1,052
Caddo			1				4,000	4,000
Canadian			2					
Carter	48	18	4		66	1,900	7,923	9,823
Cherokee			2				7,040	7,040
Choctaw			1					
Coal			1				8,500	8,500
Comanche	5	2	1		7		6,980	6,980
Cotton			2				8,000	8,000
Craig			3				2,720	2,720
Creek	1,979	903	102	95	2,787	461	37,128	37,589
Garfield			1					
Grady			1				320	320
Hughes			1				4,220	4,220
Jackson			1					
Kay	35	28	11	1	62		27,022	27,022
Kiowa	11	10	1	4	17	160	5,540	5,700
Le Flore			2				2,410	2,410
Lincoln			1				10,343	10,343
Logan			1				5,000	5,000
McIntosh			4				5,920	5,920
Marshall	3		2		3	20	1,064	1,084
Murray			2					
Muskogee	303	58	15	20	341	458	14,468	14,926
Noble			2				320	320
Nowata	5,905	929	51	248	6,586	4,732	74,407	79,139
Okfuskee		6	2		6		27,410	27,410
Okmulgee	396	380	89	30	746	5,386	140,804	146,190
Osage	1,868	464	45	60	2,272	60	552,426	552,486
Pawnee	391	271	15	24	638	266	44,919	45,185
Payne		15	3		15	124	7,609	7,733
Pittsburg			2			2,240	2,434	4,674
Pontotoc		1	1		1		8,500	8,500
Pushmataha			1				7,000	7,000
Rogers	1,705	467	48	110	2,062	1,755	31,059	32,814
Seminole			1				28,861	28,861

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Petroleum well record in 1912 and 1913, by counties—Continued.

OKLAHOMA—Continued.

1913—Continued.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Stephens			1				6,790	6,790
Tillman			3				11,500	11,500
Tulsa	1,917	879	123	51	2,745	9,855	209,451	219,306
Wagoner	6	7	14	3	10	560	3,418	3,978
Washington	4,143	1,673	105	95	5,721	8,437	169,859	178,296
Total	18,715	6,111	669	741	24,085	36,414	1,486,417	1,522,831

TEXAS.

1912.

Archer		1	8		1		17,833	17,833
Baylor			3				19,000	19,000
Bexar	3		1		3	597	44	641
Brazoria	4		3		4	3,050	1,500	4,550
Brewster	1	1			2			
Brown	6			1	5		20	20
Burleson			1					
Callahan			1				2,500	2,500
Chambers			2				1,227	1,227
Clay	151	64	14	14	201	7,404	51,162	58,566
Coleman	1		8		1	2,320	7,420	9,740
Duval	1				1	500	1,200	1,700
Edwards			2				70,000	70,000
Fayette			1					
Franklin			1				12,000	12,000
Freestone			1				2,500	2,500
Gaines			1				26,974	26,974
Hardin	845	151	28	55	941	3,546	3,725	7,271
Harris	405	101	36	88	418	2,002	26,429	28,431
Hill			1			79		79
Howard			1				5,000	5,000
Jack		2			2		1,000	1,000
Jefferson	100	36	16	33	103	73	1,027	1,100
Kaufman			2				3,000	3,000
Liberty	5	1	6	2	4	603	6,214	6,817
Limestone			1					
McCulloch		5	5		5	12,206	72,000	84,206
McLennan	12			1	11	360	360	720
McMullen	19	1			20	7,000		7,000
Marion	12	3	7	4	11	3,141	10,228	13,366
Matagorda	30	19	14	12	37	124	1,173	1,297
Maverick			1				7,127	7,127
Montgomery			2					
Navarro	797	69	22	34	832	2,155	38,430	40,585
Nueces			1			554	350,000	350,554
Polk			2				3,845	3,845
Robertson	1				1		5,000	5,000
Rusk		2			2			
Scurry			1					
Shackelford			1					
Shelby			1				1,100	1,100
Smith			1				3,000	3,000
Tarrant		1			1		7,000	7,000
Walker		1		1			2,583	2,583
Wichita	80	298	82		378	5,125	371,348	376,473
Wilbarger	1		2	1			35,524	35,524
Wilson			2			90	1,942	2,032
Wise			1				13,338	13,338
Wood			1			160	2,800	2,960
Total	2,473	757	284	246	2,984	51,089	1,186,570	1,237,659

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Petroleum well record in 1912 and 1913, by counties—Continued.

TEXAS—Continued.

1913.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Angelina			2					
Archer	1		6		1		1,202	1,202
Atascosa		4	7		4		18,874	18,874
Baylor			2					
Bee			1					
Bexar	3		3	3		1,249	2,528	3,777
Brazoria	4		2	4		3,005	5,325	8,330
Brazos			1					
Brewster	2				2			
Brown	5	1		1	5	1	8,000	8,001
Burleson		1		1				
Callahan			1					
Cass		1	1	1		13,565	3,112	16,677
Chambers			1				1,227	1,227
Clay	201	108	15	8	301	13,123	24,320	37,443
Coleman	1	4	12	4	1	2,200	35,242	37,442
Comanche			1					
Cottle			1				3,500	3,500
Delta		1			1	2,000	1,000	3,000
Duval	1		1		1		200	200
Eastland			3			10	580	590
Ellis			1				240	240
Freestone		2	2		2		3,200	3,200
Gonzales			1				1,047	1,047
Hall			1			800	800	1,600
Hardin	941	101	33	116	926	2,628	1,532	4,160
Harris	418	110	77	91	437	4,789	8,425	13,214
Hopkins			2				1,000	1,000
Houston			1					
Jack	2	14	2		16		11,323	11,323
Jasper			1				450	450
Jefferson	103	28	14	25	106	2,022	1,017	3,039
Liberty	4	3	2	1	6	383	1,500	1,883
Limestone			3				800	800
McCulloch	5	3	5	8		80	206	286
McLennan	11				11		365	365
McMullen	20				20		16,388	16,388
Madison			1					
Marion	11	14	3	1	24	6,655	19,019	25,674
Matagorda	37	7	6	5	39	1,103	1,103	2,206
Nacogdoches		2		2			5,031	5,031
Navarro	832	63	26	124	771	545	20,185	20,730
Orange		1			1	1	1,467	1,468
Panola			2			150	15,103	15,253
Polk			1					
Robertson	1			1				
Rusk	2			2			3,000	3,000
Shackelford		1	4		1		3,000	3,000
Shelby			2				5,800	5,800
Stephens			2					
Tarrant	1				1		12,000	12,000
Titus			2					
Tyler			4			640		640
Wichita	378	408	27	26	760	5,319	348,700	354,019
Wilbarger			2			960	16,902	17,862
Wilson			1				767	767
Wise			6				20,000	20,000
Wood			3			160	3,000	3,160
Young			2				223	223
Total	2,984	877	299	424	3,437	61,388	628,703	690,091

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Petroleum well record in 1912 and 1913, by counties—Continued.

LOUISIANA.

1912.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Acadia	82	46	2	21	107	642	4,157	4,799
Caddo	413	230	58	57	586	20,844	167,188	188,032
Calcasieu	58	27	21	12	73	714	933	1,647
Evangeline	.....	1	4	.....	1	800	6,907	7,707
Natchitoches	.....	.....	2	.....	.....	.....	41,400	41,400
St. Martin	2	11	3	.....	13	6,345	449	6,794
Terrebonne	.....	.....	1	.....	.....	.....	.....	.....
Total	555	315	91	90	780	29,345	221,034	250,379

1913.

Acadia	107	20	3	45	82	791	3,186	3,977
Bossier	.....	.....	2	.....	.....	1,200	2,096	3,296
Caddo	586	297	34	69	814	43,817	344,901	393,718
Calcasieu	71	30	12	21	80	464	6,008	6,472
Cameron	.....	.....	2	.....	.....	.....	40	40
De Soto	.....	2	.....	.....	2	.....	23,295	23,295
Evangeline	1	.....	3	1	.....	4,000	1,224	5,224
Jefferson Davis	2	20	2	.....	22	.....	1,455	1,455
Rapides	.....	.....	1	.....	.....	.....	301	301
Sabine	.....	.....	1	.....	.....	220	6,784	7,004
St. Martins	13	.....	.....	13	.....	2	25	27
St. Tammany	.....	.....	1	.....	.....	.....	1,200	1,200
Terrebonne	.....	.....	3	.....	.....	800	20,037	20,837
Webster	.....	.....	.....	.....	.....	2,857	.....	2,857
Total	780	369	64	149	1,000	59,151	410,552	469,703

PIPE-LINE STATISTICS.

APPALACHIAN OIL FIELD.

GENERAL CONDITIONS.

The Appalachian field embraces all oil pools east of central Ohio, including those of New York, Pennsylvania, West Virginia, southeastern Ohio, Kentucky, and Tennessee. Nearly all of this petroleum is classed as of Pennsylvania grade, with the exception of some of the oil from Kentucky and from a few isolated pools in other States. The region in general represents the oldest oil field of the United States. Most of the pools have long since passed their prime, and in New York and Pennsylvania production is kept alive chiefly by cleaning and deepening old wells or by obtaining oil from shallow sands which were passed by as too small when the wells were first drilled. Nevertheless, no pool has been entirely abandoned as exploited, and wells are still being pumped within a few yards of the original Drake well at Titusville, Pa. In West Virginia and on the eastern edge of Ohio are many pools long since on the wane, but the extension of territory and the discovery of new pools is still in actual progress in West Virginia, central Ohio, and Kentucky. Prospecting is still active in Tennessee, but so far without definitive results.

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PRODUCTION.

During 1913 the Appalachian oil field showed only a very slight decrease—1.58 per cent—in the quantity produced, the total for 1912 being 26,338,516 barrels and for 1913, 25,921,785 barrels. The average price of crude petroleum in the Appalachian field was $1.626 in 1912 and this increased to $2.458 in 1913, which yielded an increase in value of nearly $21,000,000, or 48.79 per cent.

Production of the Appalachian oil field, by States and months, 1912–1913, in barrels.

1912.

Month.	Pennsylvania.	New York.	Southeastern Ohio.	West Virginia.	Kentucky.	Total.
January	562,665	64,950	333,489	694,619	38,425	1,694,148
February	575,180	63,080	356,963	801,699	37,723	1,834,665
March	686,178	73,371	443,795	983,502	40,923	2,227,769
April	699,856	79,188	440,834	1,018,955	37,375	2,276,208
May	728,127	81,935	453,807	1,153,945	44,967	2,462,781
June	657,545	73,950	416,396	1,172,331	40,311	2,360,533
July	678,789	75,875	439,778	1,174,367	44,997	2,413,806
August	675,848	74,663	460,390	1,190,552	40,866	2,442,319
September	634,114	68,884	410,131	981,052	39,146	2,133,327
October	686,194	76,766	437,877	1,013,980	38,484	2,253,291
November	610,314	68,045	397,129	918,313	40,000	2,033,801
December	643,148	73,421	422,501	1,025,647	41,151	2,205,868
Total	7,837,948	874,128	5,013,110	12,128,962	484,368	26,338,516

1913.

January	673,011	77,029	407,538	978,401	42,074	2,178,053
February	581,040	63,692	364,307	936,733	36,843	1,982,615
March	640,858	70,684	324,609	970,900	39,391	2,046,832
April	707,638	78,771	456,072	1,026,129	39,036	2,307,646
May	704,527	79,800	420,757	1,003,425	42,932	2,251,441
June	665,380	73,981	414,698	995,098	39,285	2,188,442
July	692,201	79,091	424,588	1,009,383	48,211	2,253,474
August	656,835	74,260	410,459	939,479	49,908	2,130,941
September	655,137	74,503	425,023	928,610	52,538	2,135,811
October	698,052	80,424	456,364	956,772	46,301	2,237,913
November	612,732	70,738	406,018	839,274	44,137	1,972,899
December	675,871	78,938	453,902	983,095	43,912	2,235,718
Total	7,963,282	902,211	4,964,425	11,567,299	524,568	25,921,785

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In spite of the present decadence of the Appalachian oil field its great importance in the development of the American oil industry is depicted in the accompanying table, which shows the production of petroleum in the Appalachian oil field from 1859 to 1913; that is, the total quantity and value for each year, the total quantity and value for the entire period, and the percentage of the total production of the United States. The rise and decline of the field is illustrated by the per cent of increase or decrease of each year compared to the year before it. The actual average price per barrel shown is obtained, not from the ruling market prices but by dividing the actual amount of money received by the number of barrels. The table is also instructive in showing that up to 1875 the oil industry was entirely limited to the Appalachian field and that until 1885 this region still furnished 98.5 per cent of the total production. At this point the marked decline began, which, although not entirely continuous, has continued until the percentage of yield in the Appalachian field has fallen from 98.5 per cent in 1885 to 10.43 per cent at the end of 1913. A curious illustration of the appreciation of Appalachian oil is the fact that, while this field produced only this small percentage of the entire yield of the country in 1913, the amount of money paid for it was $63,708,981, the largest amount paid in any one year since the beginning of the industry, and this in spite of the fact that the total production has fallen from the maximum of 36,295,443 barrels in 1900 to 25,921,785 in 1913. Over $14,000,000 more was paid for the smaller yield of 1913 than for the maximum yield in 1900. This great gain in value was, of course, due to the rise in the price of oil of Pennsylvania grade in 1913. The average price for the year reached $2.458, the highest average price paid for the Appalachian oil since 1876. The total amount of money received for the oil furnished by the Appalachian field aggregates $1,435,757,094. It may be estimated that about $200,000,000 of this sum has gone to the owners of the small farms from which the oil was obtained, which would be an income since 1859 of about $45 per acre for all of the oil land in the Appalachian field, and they still own the land.

The production of petroleum in the Appalachian oil field from 1859 to 1913, inclusive, is given in the following table:

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Production of petroleum in the Appalachian field, 1859–1913, by years, in barrels.

Year.	Quantity.	Percentage of total production.	Increase or decrease.	Percentage of increase or decrease.	Value.	Yearly average price per barrel.
1859	2,000	100			$32,000	$16.000
1860	500,000	100	+ 498,000	+24,900.00	4,800,000	9.590
1861	2,113,609	100	+1,613,609	+ 322.72	1,035,068	.490
1862	3,056,690	100	+ 943,081	+ 44.62	3,209,525	1.050
1863	2,611,309	100	− 445,381	− 14.57	8,225,063	3.150
1864	2,116,109	100	− 495,200	− 18.96	20,896,576	8.060
1865	2,497,700	100	+ 381,591	+ 18.03	16,459,853	6.590
1866	3,597,700	100	+1,100,000	+ 44.04	13,455,398	3.740
1867	3,347,300	100	− 250,400	− 6.96	8,066,993	2.410
1868	3,646,117	100	+ 298,817	+ 8.93	13,217,174	3.625
1869	4,215,000	100	+ 568,883	+ 15.60	23,730,450	5.638
1870	5,260,745	100	+1,045,745	+ 24.81	20,503,754	3.900
1871	5,205,234	100	− 55,511	− 1.06	22,591,180	4.340
1872	6,293,194	100	+1,087,960	+ 20.90	21,440,503	3.640
1873	9,893,786	100	+3,600,592	+ 57.21	18,100,464	1.830
1874	10,926,945	100	+1,033,159	+ 10.44	12,647,527	1.170
1875	8,787,514	100	−2,139,431	− 19.58	7,368,133	1.350
1876	9,120,669	99.87	+ 333,155	+ 3.79	22,952,822	2.563
1877	13,337,363	99.90	+4,216,694	+ 46.23	31,756,066	2.420
1878	15,381,641	99.90	+2,044,278	+ 15.33	18,009,346	1.190
1879	19,894,288	99.90	+4,512,647	+ 29.34	17,164,836	.859
1880	26,245,571	99.85	+6,351,283	+ 31.93	24,506,963	.945
1881	27,561,376	99.64	+1,315,805	+ 5.01	23,281,324	.859
1882	30,221,261	99.58	+2,659,885	+ 9.65	23,334,016	.781
1883	23,306,776	99.39	−6,914,485	− 22.88	25,410,252	1.059
1884	23,956,438	98.92	+ 649,662	+ 2.79	19,871,704	.835
1885	21,533,785	98.51	−2,422,653	− 10.11	18,442,044	.879
1886	26,549,827	94.60	+5,016,042	+ 23.29	18,714,054	.713
1887	22,878,241	80.90	−3,671,586	− 13.83	16,259,483	.668
1888	16,941,397	61.36	−5,936,844	− 25.96	14,839,434	.876
1889	22,355,225	63.57	+5,413,828	+ 31.96	24,485,407	.941
1890	30,066,560	65.61	+7,711,335	+ 34.50	30,121,068	.868
1891	35,848,777	66.03	+5,782,217	+ 19.23	24,219,863	.670
1892	33,432,377	66.19	−2,416,400	− 6.74	18,830,773	.556
1893	31,365,890	64.76	−2,066,487	− 6.18	20,327,232	.640
1894	30,783,424	62.38	− 582,466	− 1.86	26,030,125	.839
1895	30,960,639	58.54	+ 177,215	+ .58	42,206,898	1.359
1896	33,971,902	55.73	+3,011,263	+ 9.73	40,203,418	1.179
1897	35,230,271	58.25	+1,258,369	+ 3.70	27,877,213	.786
1898	31,717,425	57.29	−3,512,846	− 9.97	29,096,057	.911
1899	33,068,356	57.94	+1,350,931	+ 4.26	43,041,677	1.294
1900	36,295,433	57.05	+3,227,077	+ 9.76	49,235,298	1.353
1901	33,618,171	48.45	−2,677,262	− 7.38	40,796,327	1.210
1902	32,018,787	36.07	−1,599,384	− 4.76	40,451,593	1.238
1903	31,558,248	31.41	− 460,539	− 1.44	49,905,813	1.590
1904	31,408,567	26.83	− 149,681	− .47	50,598,184	1.628
1905	29,366,960	21.80	−2,041,607	− 6.50	40,279,035	1.394
1906	27,741,472	21.93	−1,625,488	− 5.54	43,633,401	1.598
1907	25,342,137	15.26	−2,399,335	− 8.65	43,766,086	1.745
1908	24,945,517	13.97	− 396,620	− 1.57	43,888,020	1.780
1909	26,535,844	14.49	+1,590,327	+ 6.38	43,237,233	1.646
1910	26,892,579	12.83	+ 356,735	+ 1.33	35,841,749	1.336
1911	23,749,832	10.77	−3,142,747	− 11.37	30,830,354	1.308
1912	26,338,516	11.81	+2,588,684	+ 10.90	42,818,384	1.626
1913	25,921,785	10.43	− 416,731	− 1.58	63,708,981	2.458
Total	1,101,534,279	35.88			1,435,757,094	1.303

In the following table is shown the production of the Appalachian field, by States, in the years 1912 and 1913, with the increase and decrease for each State and the percentage of increase or decrease in 1913:

Production of petroleum in the Appalachian field in 1912 and 1913, by States, showing increase or decrease and percentage of increase or decrease, in barrels.

State.	Production.		Increase.	Decrease.	Percentage.	
	1912	1913			Increase.	Decrease.
Pennsylvania	7,837,948	7,963,282	125,334		1.600	
New York	874,128	902,211	28,083		3.212	
Southeastern Ohio	5,013,110	4,964,425		48,685		0.971
West Virginia	12,128,962	11,567,299		561,663		4.631
Kentucky	484,368	524,568	40,200		8.300	
Total	26,338,516	25,921,785		416,731		1.580

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Production, value, and average price per barrel of petroleum in the Appalachian field, 1904–1913, by States, in barrels.

Year.	Pennsylvania.			New York.			Southeastern Ohio.		
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.
1904..	11,125,762	$18,222,242	$1.637	1,113,264	$1,811,837	$1.627	5,526,571	$8,995,386	$1.627
1905..	10,437,195	14,653,278	1.404	1,117,582	1,557,630	1.393	5,016,736	6,992,885	1.393
1906..	10,256,393	16,596,943	1.618	1,243,517	1,995,377	1.605	4,906,579	7,839,359	1.597
1907..	9,999,306	17,579,706	1.758	1,212,300	2,127,748	1.755	4,214,391	7,344,408	1.742
1908..	9,424,225	16,881,194	1.791	1,160,128	2,071,533	1.786	4,110,121	7,316,617	1.780
1909..	9,299,403	15,424,554	1.658	1,134,897	1,878,217	1.655	4,717,436	7,773,880	1.648
1910..	8,794,062	11,906,914	1.354	1,053,838	1,414,668	1.342	4,822,234	6,469,939	1.342
1911..	8,248,158	10,894,074	1.321	952,515	1,248,950	1.311	4,281,237	5,591,423	1.306
1912..	7,837,948	12,886,752	1.644	874,128	1,401,880	1.604	5,013,110	8,177,189	1.631
1913..	7,963,282	19,805,452	2.487	902,211	2,169,357	2.404	4,964,425	12,229,610	2.463

Year.	West Virginia.			Kentucky-Tennessee.			Total.		
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.
1904..	12,644,686	$20,583,781	$1.628	998,284	$984,938	$0.986	31,408,567	$50,598,184	$1.611
1905..	11,578,110	16,132,631	1.393	1,217,337	943,211	.775	29,366,960	40,279,635	1.371
1906..	10,120,935	16,170,293	1.005	1,213,548	1,031,629	.850	27,741,472	43,633,601	1.573
1907..	9,095,296	15,852,428	1.743	820,344	862,396	1.051	25,342,137	43,766,686	1.729
1908..	9,523,176	16,911,865	1.776	[a] 727,767	706,811	.971	24,945,517	43,888,020	1.759
1909..	10,745,092	17,642,283	1.642	[a] 639,016	518,299	.811	26,535,844	43,237,233	1.629
1910..	11,753,071	15,723,544	1.338	[a] 468,774	324,684	.692	26,892,579	35,841,749	1.332
1911..	9,795,464	12,767,293	1.303	[a] 472,458	328,614	.695	23,749,832	30,830,354	1.298
1912..	12,128,962	19,927,721	1.643	[a] 484,368	424,842	.877	26,338,516	42,818,384	1.625
1913..	11,567,299	28,828,814	2.492	[a] 524,568	675,748	1.288	25,921,785	63,708,961	2.458

[a] No production in Tennessee recorded.

In the two following tables is given the production of petroleum in the Appalachian field from 1909 to 1913—in the first by months and in the second by days:

Production of petroleum in the Appalachian oil field, 1909–1913, by months and years, in barrels.

Month.	1909	1910	1911	1912	1913
January	1,980,577	2,274,236	1,974,600	1,694,048	2,178,053
February	1,906,109	2,019,229	1,884,336	1,834,665	1,982,615
March	2,237,778	2,494,868	2,097,333	2,227,769	2,046,832
April	2,158,382	2,296,566	1,974,135	2,276,208	2,307,646
May	2,194,131	2,349,595	2,162,336	2,462,381	2,251,441
June	2,220,071	2,382,097	2,031,071	2,360,533	2,188,442
July	2,306,654	2,289,118	1,914,966	2,413,306	2,253,474
August	2,273,277	2,325,953	2,033,142	2,442,319	2,130,941
September	2,288,067	2,208,040	1,907,771	2,133,327	2,135,811
October	2,309,498	2,148,205	1,964,172	2,253,291	2,237,913
November	2,321,230	2,046,535	1,834,182	2,033,301	1,972,899
December	2,329,270	2,107,837	1,971,408	2,205,968	2,235,718
Total	26,535,844	26,892,579	23,749,832	26,338,516	25,921,785

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Average daily production of petroleum in the Appalachian oil field each month, 1909–1913, by months and years, in barrels.

Month.	1909	1910	1911	1912	1913
January	64,180	73,362	63,697	54,647	70,280
February	68,075	72,115	67,298	63,264	70,808
March	72,186	80,480	67,656	71,864	66,027
April	71,946	76,552	65,801	74,259	76,921
May	70,795	75,793	69,769	82,029	72,627
June	74,032	79,403	67,702	76,684	72,948
July	74,408	72,230	61,773	77,865	72,698
August	73,332	75,031	65,585	78,784	68,740
September	76,269	73,601	63,592	71,111	71,194
October	74,513	69,297	63,360	72,687	72,191
November	77,374	68,228	61,139	67,793	75,763
December	75,138	67,995	63,594	71,157	72,120
Average	72,701	73,678	65,068	71,963	71,924

RUNS, STOCKS, AND DELIVERIES.

In the following tables are given the runs of Appalachian oil for the principal pipe lines in the Appalachian fields in 1912, and 1913, together with the stocks of the same at the close of each month:

Pipe-line runs of Appalachian oil in 1912, by lines and months, in barrels.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	New York Transit.	Tidewater.
January	214,880	122,234	651,770	37,697	13,049	89,239
February	219,690	123,185	756,924	36,995	13,038	92,121
March	268,486	133,574	932,405	40,196	13,922	108,002
April	282,625	126,334	971,098	36,646	16,883	111,262
May	282,533	137,181	1,101,421	44,238	16,740	115,596
June	250,379	120,237	1,125,895	39,582	14,774	107,147
July	258,814	126,039	1,121,256	44,268	15,574	105,660
August	248,731	120,296	1,133,662	40,137	15,822	108,094
September	233,625	111,048	929,369	38,417	15,060	97,329
October	249,239	116,320	954,537	37,756	16,948	110,429
November	213,913	108,629	859,982	39,272	14,721	95,920
December	216,634	111,360	961,346	40,343	15,760	102,274
Total	2,939,549	1,456,437	11,499,665	475,546	182,291	1,243,062

Month.	Producers and Refiners.	Emery.	Buckeye Macksburg.	Franklin.	Other lines.	Total.
January	144,391	23,802	273,483	1,822	121,791	1,694,148
February	141,020	23,514	300,580	2,094	125,204	1,834,665
March	164,865	28,700	380,187	3,652	153,781	2,227,769
April	158,520	28,160	377,519	3,690	163,471	2,276,208
May	169,039	27,693	385,050	3,744	179,547	2,462,781
June	157,740	25,472	353,926	2,972	162,409	2,360,533
July	166,630	27,015	370,090	3,161	175,299	2,413,806
August	179,696	28,598	378,369	3,510	185,404	2,442,319
September	170,121	24,951	335,470	3,066	174,851	2,133,327
October	202,172	28,373	337,329	2,989	197,199	2,253,291
November	205,365	24,348	288,237	2,900	180,514	2,033,801
December	221,976	27,087	303,531	3,394	202,163	2,205,868
Total	2,081,535	317,713	4,084,071	37,014	2,021,633	26,338,516

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Pipe-line runs of Appalachian oil in 1913, by lines and months, in barrels.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	New York Transit.	Tidewater.
January	232,522	112,656	912,474	41,982	16,490	108,701
February	185,868	99,833	873,681	36,751	14,017	91,662
March	215,895	110,962	906,441	39,194	14,867	100,991
April	255,401	116,693	958,267	38,795	17,440	109,987
May	241,235	119,006	933,113	42,716	17,453	109,932
June	227,623	111,617	929,857	39,069	15,668	104,516
July	236,553	114,617	942,294	48,119	17,494	111,650
August	218,931	112,786	873,104	49,766	15,939	105,442
September	226,499	109,337	866,056	52,328	16,294	104,504
October	238,832	117,589	889,964	46,082	18,129	109,926
November	207,024	99,321	771,387	43,929	15,894	98,493
December	221,142	116,100	907,714	43,822	16,825	111,445
Total	2,707,525	1,340,517	10,764,342	522,553	196,510	1,267,249

Month.	Producers and Refiners.	Emery.	Buckeye Macksburg.	Franklin.	Other lines.	Total.
January	212,519	27,208	289,530	3,002	220,969	2,178,053
February	191,944	23,855	256,638	2,349	206,017	1,982,615
March	190,278	25,880	224,756	3,023	214,545	2,046,832
April	207,788	29,156	342,599	3,423	228,097	2,307,646
May	219,848	28,536	306,088	3,106	234,108	2,351,441
June	198,268	27,890	306,680	3,158	224,095	2,188,442
July	197,774	29,586	313,968	3,402	238,017	2,253,474
August	197,462	29,450	297,418	2,861	227,782	2,130,941
September	201,008	28,269	302,820	3,155	225,441	2,135,811
October	214,376	29,587	324,425	3,196	245,817	2,237,913
November	198,023	26,756	281,991	2,890	227,191	1,972,899
December	221,843	29,762	313,049	3,396	250,620	2,235,718
Total	2,451,131	335,935	3,559,962	36,961	2,739,100	25,921,785

Stocks held by eastern [a] pipe lines and refineries in the Appalachian field at close of each month in 1912 and 1913, in barrels.

1912.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	Southern.	Crescent.
Dec. 31, 1911	1,161,046	996,483	1,302,420	178,544	637,852	84,612
January	1,118,967	1,031,549	1,354,971	176,431	636,789	97,443
February	1,083,298	1,027,835	1,436,968	169,683	561,145	113,489
March	1,156,060	1,030,083	1,456,423	192,189	606,793	96,290
April	1,106,056	844,441	1,450,351	197,663	617,113	102,182
May	1,271,181	843,314	1,339,603	216,700	655,706	75,367
June	1,161,394	733,850	1,484,997	212,287	606,946	92,974
July	1,104,934	754,661	1,459,698	204,665	646,831	91,460
August	1,153,372	892,819	1,442,613	202,104	613,915	85,278
September	1,206,089	627,339	1,423,452	196,895	664,063	104,004
October	1,142,205	603,213	1,332,901	170,686	557,055	56,062
November	1,027,972	554,519	1,237,112	150,953	563,915	52,703
December	889,359	522,506	1,532,946	129,225	573,740	72,121

Month.	New York Transit.	Tidewater.	Northern.	Producers and Refiners.	Emery.	United States.
Dec. 31, 1911	2,488,641	291,069	1,672,216	197,827	12,767	58,137
January	2,589,080	252,541	1,236,093	211,136	16,550	8,276
February	2,107,099	245,586	947,517	206,624	17,774	11,005
March	1,512,481	269,190	1,113,766	188,119	18,111	42,570
April	1,268,986	256,825	1,046,753	175,762	19,253	41,659
May	1,215,929	249,697	1,069,244	208,493	22,178	41,599
June	1,204,030	237,349	844,989	219,768	21,268	27,628
July	669,751	227,731	716,741	188,387	21,206	37,449
August	674,991	255,706	675,423	178,356	20,408	21,539
September	758,872	269,511	694,682	187,499	15,340	23,706
October	815,188	247,021	688,689	217,818	19,739	12,113
November	938,922	239,547	787,634	234,066	21,567	29,202
December	1,154,211	200,337	575,730	274,921	23,565	2,918

[a] These pipe lines connect with the delivering lines of the Illinois, Kansas, and Oklahoma fields and receive and transfer large quantities of these western oils to the Atlantic seaboard in addition to the oil from wells directly tributary to their own systems.

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Stocks held by eastern pipe lines and refineries in the Appalachian field at close of each month in 1912 and 1913, in barrels—Continued.

Month.	Buckeye Macksburg.	Buckeye Lima.	Indiana.	Franklin.	Other lines.	Total.
Dec. 31, 1911	282,090	4,066,820	965,890	59,998	70,659	14,527,071
January	307,823	3,697,265	939,800	53,453	69,006	13,797,773
February	346,231	3,984,320	1,036,868	50,295	68,176	13,414,214
March	362,309	3,769,143	913,465	51,584	66,868	12,845,744
April	397,155	3,331,890	1,024,989	55,274	65,860	12,004,112
May	406,146	3,204,185	1,019,320	59,019	63,256	11,960,939
June	401,033	3,307,593	970,288	61,990	63,762	11,652,141
July	424,608	3,483,200	1,070,395	65,151	63,105	11,229,973
August	390,059	3,810,159	1,120,611	68,173	64,140	11,669,556
September	364,477	3,934,567	1,017,383	70,772	65,167	11,624,820
October	314,249	3,623,883	1,030,069	67,664	67,698	10,966,273
November	339,455	3,377,926	993,918	59,145	71,818	10,680,074
December	384,553	3,291,256	963,306	50,581	90,070	10,731,345

1913.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	Southern.	Crescent.
January	908,334	584,821	1,516,769	130,015	542,471	70,940
February	819,841	538,377	1,672,659	127,827	482,092	63,470
March	911,573	590,253	1,425,056	134,667	528,003	54,488
April	948,189	585,328	1,465,167	119,553	554,293	69,650
May	1,016,316	614,375	1,597,633	90,505	574,943	66,310
June	1,026,373	598,138	1,423,023	69,450	619,540	84,902
July	1,016,054	713,190	1,621,131	61,753	509,805	144,145
August	1,021,246	931,360	1,567,997	74,766	621,581	152,734
September	1,062,998	884,470	1,619,751	82,315	693,024	145,609
October	1,084,617	822,227	1,562,704	93,425	750,172	149,980
November	1,066,294	742,656	1,349,754	96,980	760,959	126,903
December	995,843	688,801	1,596,501	85,107	681,649	62,409

Month.	New York. Transit.	Tidewater.	Northern.	Producers and Refiners.	Emery.	Buckeye Macksburg.
January	982,526	236,694	764,454	280,289	25,897	386,633
February	1,093,300	277,971	650,356	275,146	18,127	402,421
March	914,520	244,941	599,164	272,637	14,818	411,354
April	738,626	254,972	768,128	283,399	16,581	378,585
May	698,219	231,215	635,819	271,770	17,305	329,778
June	673,314	230,944	535,306	284,821	16,596	396,723
July	643,068	219,944	675,394	287,528	16,896	402,789
August	641,373	272,061	592,229	276,350	19,826	363,288
September	740,480	247,887	635,902	297,120	16,595	348,266
October	883,814	261,607	739,086	328,447	18,628	347,057
November	762,718	244,798	583,978	333,598	18,354	351,262
December	710,769	330,265	595,555	359,730	16,789	369,687

Month.	Buckeye Lima.	Indiana.	Franklin.	Other lines.	Total.
January	2,984,167	976,297	46,815	134,732	10,571,854
February	3,093,215	909,049	45,783	105,062	10,574,696
March	3,297,015	849,428	48,806	114,621	10,411,344
April	3,316,909	809,724	49,583	126,167	10,484,954
May	2,980,576	794,842	52,689	138,559	10,110,854
June	3,218,981	844,830	55,846	152,368	10,231,155
July	2,871,364	798,754	59,249	166,498	10,207,462
August	2,817,325	867,482	62,110	156,857	10,439,085
September	2,728,319	818,690	65,019	173,455	10,560,402
October	2,362,961	912,670	63,683	141,630	10,522,708
November	2,208,108	956,283	55,478	164,070	9,822,193
December	2,177,747	965,099	58,391	196,321	9,890,658

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Stocks of all grades of petroleum held by eastern[a] pipe lines and refineries in the Appalachian field at close of each month in 1912 and 1913, in barrels.

1912.

Month.	Pennsylvania.[b]	Lima.	Illinois.	Kentucky.	Kansas and Oklahoma.	Total.
Dec. 31, 1911	4,479,779	3,147,427	2,795,623	254,763	3,849,479	14,527,071
January	3,932,010	2,967,738	2,634,323	281,784	3,982,418	13,797,773
February	4,120,518	2,990,299	2,295,660	210,438	3,797,199	13,414,214
March	4,318,220	3,010,540	2,060,145	238,629	3,218,210	12,845,744
April	4,395,584	3,022,377	1,588,377	260,150	2,737,524	12,004,112
May	4,571,266	2,494,149	2,014,188	295,839	2,585,497	11,960,939
June	4,498,327	2,515,579	1,569,501	301,827	2,766,907	11,652,141
July	4,436,048	2,151,548	2,158,242	304,665	2,179,370	11,229,973
August	4,214,458	2,307,132	2,626,532	324,889	2,196,145	11,669,556
September	4,092,873	2,444,979	2,616,520	281,825	2,188,823	11,624,820
October	3,736,433	2,135,501	2,752,499	296,345	2,046,495	10,966,273
November	3,748,178	2,134,042	2,483,692	262,909	2,050,853	10,680,074
December	3,804,483	2,297,961	2,368,271	226,035	2,034,695	10,731,345

1913.

January	3,936,422	2,338,451	1,908,683	262,970	2,125,328	10,571,854
February	4,102,909	2,239,049	1,866,847	214,398	2,151,593	10,574,696
March	4,126,930	2,132,306	1,744,862	249,358	2,158,788	10,411,344
April	4,166,479	2,229,721	1,559,509	224,365	2,304,880	10,484,954
May	4,203,768	2,045,213	1,544,526	230,079	2,087,268	10,110,854
June	4,121,276	1,955,272	1,903,773	127,941	2,122,893	10,231,155
July	4,184,997	2,031,608	1,792,595	184,862	2,014,310	10,207,462
August	4,249,284	1,943,838	2,068,928	147,891	2,029,144	10,439,085
September	4,484,194	2,026,513	1,638,927	191,497	2,219,279	10,560,400
October	4,552,557	1,778,509	1,680,136	211,477	2,300,029	10,522,708
November	4,373,575	1,645,457	1,093,294	192,177	2,517,890	9,822,193
December	4,387,718	1,623,461	1,079,468	230,706	2,569,805	9,890,658

[a] These pipe lines connect with the delivering lines of the Illinois, Kansas, and Oklahoma fields and receive and transfer large quantities of these western oils to the Atlantic seaboard in addition to the oil from wells directly tributary to their own systems.

[b] Includes natural lubricating oil from Pennsylvania and West Virginia.

Pipe-line runs and deliveries to trade of petroleum from the Appalachian field, by months, in barrels, in 1912 and 1913, and stocks at end of each month.

	1912			1913		
	Runs.	Deliveries.	Stocks.	Runs.	Deliveries.	Stocks.
Dec. 31, 1911			4,734,542			
January	1,694,148	2,214,896	4,213,794	2,178,053	2,009,179	4,199,392
February	1,834,665	1,717,403	4,331,056	1,982,615	1,864,800	4,317,207
March	2,227,769	2,001,976	4,556,849	2,046,832	1,988,651	4,375,388
April	2,276,208	2,177,323	4,655,734	2,307,646	2,292,190	4,390,844
May	2,462,781	2,251,410	4,867,105	2,251,441	2,208,438	4,433,847
June	2,360,533	2,427,484	4,800,154	2,188,442	2,373,072	4,249,217
July	2,413,806	2,473,247	4,740,713	2,253,474	2,133,732	4,368,959
August	2,442,319	2,643,485	4,539,547	2,130,941	2,102,725	4,397,175
September	2,133,327	2,298,176	4,374,698	2,135,811	1,857,305	4,675,681
October	2,253,291	2,596,211	4,031,778	2,237,913	2,149,560	4,764,034
November	2,033,801	2,054,492	4,011,087	1,972,899	2,171,181	4,565,752
December	2,205,868	2,186,437	4,030,518	2,235,718	2,183,046	4,618,424
Total	26,338,516	27,042,540		25,921,785	25,333,879	

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Pipe-line deliveries to trade of eastern [a] pipe lines in 1912 and 1913, by lines and months, in barrels.

1912.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	Southern.	Crescent.	New York Transit.
January	1,669,651	160,732	74,074	9,224	545,409	142,686	1,222,506
February	1,550,924	172,479	79,700	8,527	562,158	128,286	1,193,716
March	1,637,163	153,197	84,821	13,018	531,112	172,336	1,130,495
April	1,712,503	178,253	89,373	14,242	629,898	151,847	1,416,061
May	1,701,842	176,315	75,502	8,138	615,042	159,624	1,537,048
June	1,824,053	172,665	83,914	7,220	618,651	145,253	1,276,068
July	1,783,285	171,153	75,752	5,652	666,638	163,495	1,407,578
August	1,799,723	175,327	74,342	3,263	673,661	165,288	979,277
September	1,674,071	174,917	74,417	4,314	583,311	131,041	969,800
October	1,824,043	192,126	78,474	4,677	720,263	202,397	1,275,394
November	1,614,560	182,905	78,501	5,760	550,831	153,080	951,080
December	1,518,812	174,501	77,556	3,996	513,238	134,571	1,071,652
Total	20,310,630	2,084,470	946,426	88,031	7,210,212	1,849,904	14,430,655

Month.	Tidewater.	Producers and Refiners.	Emery.	United States.	Buckeye Macksburg.	Franklin.
January	153,929	131,082	20,019	30,453	6,349	8,367
February	180,313	145,532	22,290	19	6,460	5,252
March	166,172	183,371	28,363	7,413	6,473	2,363
April	178,791	170,877	27,018	33,082	6,802	.....
May	152,875	136,308	24,768	2,945	7,105	.....
June	190,278	146,466	26,383	16,241	6,431	.....
July	146,629	198,010	27,077	14,277	8,484	.....
August	141,793	189,728	29,396	29,758	7,287	488
September	114,922	160,977	30,019	12,209	7,569	487
October	175,835	171,853	23,974	28,277	7,636	6,097
November	174,446	189,117	22,519	9,788	7,080	11,418
December	188,023	181,122	25,089	12,811	7,234	11,959
Total	1,964,006	2,004,443	306,915	197,273	84,910	46,431

1913.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	Southern.	Crescent.
January	1,552,099	1,130,864	1,877,513	5,645	560,684	153,530
February	1,248,553	806,234	1,346,751	4,070	512,211	139,194
March	1,366,476	934,991	1,778,912	5,138	477,243	138,710
April	1,569,347	1,056,217	1,822,396	4,253	458,974	111,072
May	1,523,498	995,079	1,651,699	6,731	516,293	158,982
June	1,724,225	990,236	1,888,633	6,546	491,629	132,085
July	1,659,852	1,222,957	1,763,218	6,340	400,655	95,570
August	1,686,383	1,241,033	1,997,891	6,309	455,691	148,123
September	1,536,042	1,088,071	1,761,384	6,035	404,676	147,776
October	1,801,939	1,185,241	1,914,394	2,016	323,350	142,436
November	1,671,363	1,031,435	1,812,578	2,128	418,888	108,325
December	1,478,092	1,013,789	1,510,240	3,112	489,590	116,927
Total	18,817,869	12,696,147	21,125,609	58,323	5,509,884	1,592,730

[a] These pipe lines connect with the delivering lines of the Illinois, Kansas, and Oklahoma fields and receive and transfer large quantities of these western oils to the Atlantic seaboard in addition to the oil from wells directly tributary to their own systems.

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Pipe-line deliveries to trade of eastern pipe lines in 1912 and 1913, by lines and months, in barrels—Continued.

1913—Continued.

Month.	New York Transit.	Tidewater.	Producers and Refiners.	Emery.	Buckeye Macksburg.	Franklin.
January	1,035,053	146,819	207,150	24,876	7,854	6,768
February	1,233,939	104,704	197,087	31,625	6,586	3,381
March	1,028,170	181,633	192,734	29,190	7,226	.....
April	1,281,569	168,434	196,702	27,393	51	2,646
May	1,484,141	166,865	220,831	27,812	721	.....
June	1,352,261	159,029	185,241	28,241	1,270	.....
July	1,328,813	185,651	195,068	29,286	242	.....
August	1,396,158	99,260	208,614	26,519	11	.....
September	1,151,096	179,971	180,236	31,500	242	246
October	1,269,135	161,263	183,004	27,554	.....	4,531
November	1,332,253	157,635	192,917	27,030	.....	11,095
December	1,027,792	79,786	195,711	31,327	.....	482
Total	14,920,400	1,791,050	2,353,981	342,353	24,208	29,149

PRICES OF APPALACHIAN OIL.

The following table shows the range of prices paid by the Seep Purchasing Agency for the different grades of oil in the Appalachian field in 1911, 1912, and 1913:

Range of prices paid at wells by the Seep Purchasing Agency for petroleum produced in the New York, southeastern Ohio, Pennsylvania, West Virginia, and Kentucky oil regions during 1911, 1912, and 1913, per barrel of 42 gallons.

Date.	Pennsylvania and Tiona, Pa.	Mercer black, Pennsylvania.	Corning, Ohio.	New Castle, Ohio.	Cabell, W. Va.	Somerset, Ky. (light).	Ragland, Ky. (heavy).
1911.							
Jan. 1	$1.30	$0.87	$0.77	$0.84	$0.94	$0.72	$0.45
Sept. 15	.....	.....	.....	.....	.....	.74	.....
Dec. 26	1.35	.92	.82	.89	.99	.79	.48
1912.							
Jan. 1	1.35	.92	.82	.89	.99	.79	.48
Jan. 8	1.40	.97	.87	.94	1.04	.....	.....
Jan. 22	1.45	1.02	.92	.99	1.09	.81	.....
Jan. 29	1.50	1.05	.95	1.02	1.12	.83	.....
Apr. 19	1.55	1.08	.98	1.05	1.15	.86	.50
June 5	1.60	1.13	1.03	1.10	1.20	.91	.53
June 15	.....	.....	1.13	1.13	.....	.....	.....
Oct. 29	1.65	1.18	1.18	1.18	1.25	.96	.56
Nov. 8	1.70	1.23	1.23	1.23	1.30	1.00	.60
Nov. 14	1.75	1.28	1.28	1.28	1.35	1.05	.65
Nov. 18	1.80	1.33	1.33	1.33	1.40	1.07	.....
Nov. 23	1.85	1.38	1.38	1.38	1.45	1.10	.....
Dec. 2	1.90	1.43	1.43	1.43	1.50	.....	.....
Dec. 9	1.95	1.48	1.48	1.48	1.55	1.12	.....
Dec. 14	2.00	1.53	1.53	1.53	1.60	1.15	.....
1913.							
Jan. 1	2.00	1.53	1.53	1.53	1.60	1.15	.65
Jan. 6	2.05	1.58	1.58	1.58	1.65	1.20	.68
Jan. 27	2.12	1.65	1.65	1.65	1.72	1.25	.....
Jan. 28	2.19	1.72	1.72	1.72	1.79	1.30	.....
Jan. 29	2.26	1.79	1.79	1.79	1.86	1.32	.70
Jan. 30	2.33	1.86	1.86	1.86	1.93	.....	.....
Feb. 1	2.40	1.93	1.93	1.93	2.00	.....	.....
Feb. 4	2.47	2.00	2.00	2.00	2.07	1.35	.....
Feb. 5	2.50	.....	.....	.....	.....	.....	.....

NOTE.—In addition to these prices bonuses ranging from 2 to 10 cents a barrel were paid by various pipe lines and refineries.

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In the following table is given the average price per month of the different oils of the Appalachian field during the years 1912 and 1913:

Average monthly prices of Appalachian petroleum in 1912 and 1913, per barrel.

Month.	Pennsylvania and Tiona, Pa.	Mercer black, Pennsylvania.	Corning, Ohio.	New Castle, Ohio.	Cabell, W. Va.	Somerset, Ky.	Ragland, Ky.
1912.							
January	$1.41	$0.98	$0.88	$0.95	$1.05	$0.810	$0.480
February	1.50	1.05	.95	1.02	1.12	.830	.480
March	1.50	1.05	.95	1.02	1.12	.830	.480
April	1.52	1.06	.96	1.03	1.13	.845	.490
May	1.55	1.08	.98	1.05	1.15	.860	.500
June	1.59	1.12	1.08	1.11	1.19	.885	.515
July	1.60	1.13	1.13	1.13	1.20	.910	.530
August	1.60	1.13	1.13	1.13	1.20	.910	.530
September	1.60	1.13	1.13	1.13	1.20	.910	.530
October	1.60	1.13	1.13	1.13	1.20	.935	.545
November	1.75	1.28	1.28	1.28	1.35	1.086	.603
December	1.96	1.49	1.49	1.49	1.56	1.123	.650
Average	1.598	1.136	1.091	1.123	1.206	.907	.528
1913.							
January	2.07	1.60	1.60	1.60	1.67	1.21	.68
February	2.49	1.99	1.99	1.99	2.06	1.35	.70
March	2.50	2.00	2.00	2.00	2.07	1.35	.70
April	2.50	2.00	2.00	2.00	2.07	1.35	.70
May	2.50	2.00	2.00	2.00	2.07	1.35	.70
June	2.50	2.00	2.00	2.00	2.07	1.35	.70
July	2.50	2.00	2.00	2.00	2.07	1.35	.70
August	2.50	2.00	2.00	2.00	2.07	1.35	.70
September	2.50	2.00	2.00	2.00	2.07	1.35	.70
October	2.50	2.00	2.00	2.00	2.07	1.35	.70
November	2.50	2.00	2.00	2.00	2.07	1.35	.70
December	2.50	2.00	2.00	2.00	2.07	1.35	.70
Average	2.463	1.966	1.966	1.966	2.036	1.339	.699

The average monthly and yearly prices per barrel of petroleum of Pennsylvania grade at wells in the years 1904–1913 are given in the following table:

Monthly and yearly average prices of pipe-line certificates of petroleum of Pennsylvania grade at wells in daily market, 1904–1913, per barrel.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
1904	$1.85	$1.82	$1.72½	$1.65½	$1.62	$1.58⅝	$1.52	$1.50	$1.53⅛	$1.56	$1.58⅛	$1.57	$1.628
1905	1.43½	1.39	1.38½	1.32⅛	1.28⅛	1.27	1.27	1.27	1.35⅛	1.57⅛	1.59	1.58	1.394
1906	1.58	1.58	1.58	1.60⅜	1.64	1.64	1.63⅜	1.58	1.58	1.58	1.58	1.58	1.598
1907	1.58	1.61½	1.72½	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.745
1908	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.780
1909	1.78	1.78	1.78	1.78	1.70	1.67½	1.60½	1.58	1.58	1.56½	1.49	1.44⅜	1.646
1910	1.40½	1.40	1.40	1.36½	1.35	1.31½	1.30	1.30	1.30	1.30	1.30	1.30	1.336
1911	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.31	1.301
1912	1.41	1.50	1.50	1.52	1.55	1.59	1.60	1.60	1.60	1.60	1.75	1.96	1.598
1913	2.07	2.49	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.463

The following table shows the range of prices of crude oil of Pennsylvania grade each year since 1859:

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Highest and lowest prices of crude petroleum of Pennsylvania grade each year, 1859–1913, per barrel.

Year.	Highest.		Lowest.	
	Month.	Price.	Month.	Price.
1859	September	$20.00	December	$20.00
1860	January	20.00	....do	2.00
1861	....do	1.75	....do	.10
1862	December	2.50	January	.10
1863	....do	4.00	....do	2.00
1864	July	14.00	February	3.75
1865	January	10.00	August	4.00
1866	....do	5.50	December	1.35
1867	October	4.00	June	1.50
1868	July	5.75	January	1.70
1869	January	7.00	December	4.25
1870	....do	4.90	August	2.75
1871	June	5.25	January	3.25
1872	October	4.55	December	2.67½
1873	January	2.75	November	.82½
1874	February	2.25	....do	.62½
1875	....do	1.82½	January	.75
1876	December	4.23½	....do	1.47½
1877	January	3.69½	June	1.53½
1878	February	1.87½	September	.78½
1879	December	1.28½	June	.62½
1880	June	1.24½	April	.71½
1881	September	1.01½	July	.72½
1882	November	1.37	....do	.49½
1883	June	1.24½	January	.83½
1884	January	1.15½	June	.51½
1885	October	1.12½	January	.68
1886	January	.92½	August	.59½
1887	December	.90	July	.54
1888	March	1.00	June	.71½
1889	November	1.12½	April	.79½
1890	January	1.07½	December	.60½
1891	February	.81½	August	.50
1892	January	.64½	October	.50
1893	December	.80	January	.52½
1894	....do	.95½	....do	.78½
1895	April	2.60	....do	.95½
1896	January	1.50	December	.90
1897	March	.96	October	.65
1898	December	1.19	January	.65
1899	....do	1.66	February	1.13
1900	January	1.68	November	1.05
1901	January, September	1.45	May	.80
1902	December	1.54	January, February, March	1.15
1903	....do	1.90	January, February, March, April, May, June, July.	1.50
1904	January	1.85	July, December	1.50
1905	October	1.61	May	1.27
1906	April, May, June, July	1.64	January, February, March, April, August, September, October, November, December.	1.58
1907	March to December, inclusive	1.78	January	1.58
1908	No change	1.78	No change	1.78
1909	January, February, March	1.78	December	1.43
1910	January	1.43	June to December, inclusive	1.30
1911	December	1.35	January to December	1.30
1912	....do	2.00	January	1.35
1913	March to December, inclusive	2.50	....do	2.00

WELL RECORD.

Number of wells completed in the Appalachian field, 1909–1913, by States.

State.	Oil.					Dry.					Total completed.a				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Pennsylvania and New York	3,560	1,673	1,491	1,911	3,420	a 663	a 528	b 297	b 322	b 521	4,223	2,201	2,007	2,472	4,251
Southeastern and central Ohio	1,460	953	765	846	1,246	a 820	a 686	b 512	b 460	b 603	2,280	1,639	1,680	1,717	2,191
West Virginia	1,134	897	622	1,062	1,285	a 723	a 719	b 218	b 234	b 339	1,857	1,616	1,191	1,657	2,065
Kentucky	92	70	100	112	133	a 79	a 51	b 33	b 61	b 69	171	121	136	178	210
Total	6,246	3,593	2,978	3,931	6,084	a 2,285	a 1,984	b 1,060	b 1,077	b 1,532	8,531	5,577	5,014	6,024	8,717

a Including gas wells.

b Not including gas wells.

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Number of oil wells and dry holes drilled in the Appalachian field in 1913, by States and months.

State.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Pennsylvania and New York	153	26	129	27	204	36	248	48	303	37	375	49	352	53
Southeastern and central Ohio	66	45	76	51	95	36	94	44	123	46	110	49	104	50
West Virginia	92	21	98	26	91	30	113	25	108	25	138	34	102	30
Kentucky	6	4	15	7	4	4	11	9	12	4	9	7	11	6
Total	317	96	318	111	394	106	466	126	541	112	632	139	569	139

State.	Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Pennsylvania and New York	344	57	335	56	356	45	341	37	280	50	3,420	521	1,911	322
Southeastern and central Ohio	131	61	122	49	120	57	105	49	100	66	1,246	603	846	460
West Virginia	110	32	104	30	114	28	109	31	111	27	1,285	339	1,062	234
Kentucky	10	5	19	7	11	2	10	4	15	10	133	69	112	61
Total	595	155	580	142	601	132	565	121	506	153	6,084	1,532	3,931	1,077

Number of oil wells drilled in the Appalachian field, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	452	425	409	529	599	664	611	567	592	451	545	402	6,246
1910	277	252	251	307	402	398	354	302	307	270	279	194	3,593
1911	188	180	168	196	249	277	274	288	290	292	300	276	2,978
1912	182	173	223	300	346	397	386	429	396	386	352	361	3,931
1913	317	318	394	466	541	632	569	595	580	601	565	506	6,084

Number of dry holes drilled in the Appalachian field, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	167	165	161	177	171	189	216	239	214	186	215	185	[a] 2,285
1910	125	117	125	183	172	202	183	167	173	175	156	206	[a] 1,984
1911	81	86	90	82	82	91	101	115	77	90	83	82	[b] 1,060
1912	73	43	82	65	78	79	96	121	140	102	100	96	[b] 1,077
1913	96	111	106	126	112	139	139	155	142	132	121	153	[b] 1,532

[a] Including gas wells. [b] Not including gas wells.

Total number of wells completed in the Appalachian field, 1909–1913, by months.[a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	619	590	570	706	770	853	827	806	806	637	760	587	8,531
1910	402	370	376	490	573	600	537	469	480	445	435	400	5,577
1911	347	345	326	352	405	440	459	472	459	483	491	435	5,014
1912	311	260	360	427	491	573	570	636	670	622	562	542	6,024
1913	513	528	585	675	727	829	786	846	814	855	793	766	8,717

[a] Including gas wells.

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Initial daily production of new wells completed in the Appalachian field in 1913, by States and months, in barrels.

State.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total, 1913	Total, 1913
Pennsylvania and New York	426	387	733	638	729	959	839	860	826	891	869	802	8,958	6,771
Southeastern and central Ohio	871	1,116	1,241	1,023	1,328	1,282	1,507	1,609	1,559	2,159	1,784	823	16,302	24,193
West Virginia	3,428	3,988	3,144	4,121	2,360	5,085	1,846	2,527	1,846	2,452	1,795	2,243	34,835	109,804
Kentucky	43	325	105	501	93	138	221	166	192	124	109	198	2,215	1,943
Total	4,768	5,816	5,223	6,283	4,510	7,464	4,412	5,162	4,423	5,626	4,557	4,066	62,310	142,711

Total and average initial production of new wells in the Appalachian field, 1909–1913, by States, in barrels.

State.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Pennsylvania and New York	11,333	6,683	4,912	6,771	8,958	3.18	3.99	3.29	3.54	2.62
Southeastern and central Ohio	26,152	18,116	10,923	24,193	16,302	17.91	19.01	14.28	28.60	13.08
West Virginia	43,464	26,194	10,443	109,804	34,835	33.33	29.20	16.79	103.39	27.11
Kentucky	2,186	829	1,822	1,943	2,215	23.76	11.84	18.23	17.35	16.65
Total	83,135	51,822	28,100	142,711	62,310	13.31	14.42	9.44	36.30	10.24

Total initial daily production of new wells in the Appalachian field, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909	4,819	5,184	4,783	5,161	5,646	7,512	6,809	7,593	6,476	10,660	7,115	11,377	83,135	6,928
1910	6,429	5,429	4,741	5,498	5,903	5,316	3,616	3,356	4,049	3,186	2,720	1,579	51,822	4,319
1911	1,916	2,349	1,694	2,036	2,708	1,933	2,222	2,444	2,470	2,417	3,354	2,557	28,100	2,342
1912	4,417	10,835	11,523	18,781	22,986	22,836	16,199	9,751	6,466	6,758	4,251	7,903	142,711	11,893
1913	4,768	5,816	5,223	6,283	4,510	7,464	4,412	5,162	4,423	5,626	4,557	4,066	62,310	5,193

PENNSYLVANIA AND NEW YORK.

DEVELOPMENT.

Pennsylvania.—The stimulation by high prices was so great as to change a usual decline in production of 5 or 6 per cent into a very slight increase—1.60 per cent. A total of 7,963,282 barrels was produced in 1913, against 7,837,948 barrels in 1912. The gain in value was very great. The total value was $19,805,452 in 1913 and $12,886,752 in 1912, at an average price of $2.49 in 1913 compared with $1.64 in 1912.

The oil regions spread over so much territory in western Pennsylvania, including pools scattered from the New York to the West Virginia and Ohio boundaries, that the productive conditions vary considerably in different pools. All have long passed their prime, but they differ in their stages of exhaustion. Those in Venango County, in the Bradford area, and in the northern portion of the State

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generally include the pools which originated the oil industry in the United States and developed international oil commerce, although Canada's oil production began at about the same time, and Roumania also was a productive country before the advent of Drake, who drilled the first American well for oil. The wells in the southwestern counties of Pennsylvania have been drilled more recently.

It is a matter of some national pride that the spirit of thrift and conservatism in New York and Pennsylvania has kept these old wells productive, with no other aid than the homely ingenuity of the citizens of these States, who have contrived marvelously economical and efficient means to keep the wells pumping with little recourse to special legislation on the one hand or the use of large capital on the other.

The fact is to be emphasized also, in accounting for this feat in increasing the production from those old pools, that it was due chiefly to skillful work in once more cleaning out wells that have previously been cleaned again and again, rather than to new production. In the southwestern counties of Pennsylvania some encouraging wells were drilled. Thus in Washington County, near Venice, early in the year several new wells started with 35 to 50 barrels a day. In Allegheny County interest was stimulated by a 250 barrel well near Duff City, and a 40-barrel well was struck near Walkers Mills. In Greene County the Bristoria field yielded a few promising wells, and a 35-barrel well was obtained in Westmoreland County. Butler County, near Parker, gave a few 15-barrel wells.

New York.—The increase in the price of petroleum which began at the end of 1912 had the desired effect of stimulating drilling activity in all the Appalachian States. In New York this took the form chiefly of cleaning out old wells, with an immediate increase in production. In January, 1913, the production rose from a monthly total of 73,421 barrels to 77,029 barrels. February, besides being a short month, always shows low production, because of severe weather, but the production in 1913 was slightly greater than for the same month in 1912. The spring months showed a decline from the previous year, but the gain was nearly continuous during the drilling season and up to the close of the year, so that for the first time in seven years New York showed a gain in production. The increase amounted to 3.21 per cent, or from 874,128 barrels in 1912 to 902,211 barrels. Although this total is negligible in the output of the whole country, the gain is significant in showing what a rise in price can effect in a State where the average yield per well is less than anywhere else on earth. The usual course of production in New York for several years has been a decline of about 7 or 8 per cent, so that the change to 3.21 per cent increase is really significant. The total value increased from $1,401,880 to $2,169,357, or 54.75 per cent, which was phenomenal. The average price for the year 1912 was $1.60 and for 1913 it was $2.40 per barrel of 42 gallons.

PRODUCTION.

The following table shows the production of petroleum in Pennsylvania and New York, 1909–1913, by months:

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Production of petroleum in Pennsylvania and New York in 1909–1913, by months, in barrels.

PENNSYLVANIA.

Month.	1909	1910	1911	1912	1913
January	759,178	721,627	697,290	562,665	673,011
February	704,391	621,467	637,719	575,180	581,040
March	822,600	851,225	722,755	686,178	640,858
April	784,155	766,700	701,489	699,856	707,638
May	818,359	759,585	765,470	728,127	704,527
June	820,155	790,520	704,082	657,545	665,380
July	792,327	723,646	668,324	678,789	692,210
August	786,563	763,273	704,627	675,848	656,835
September	774,750	720,165	661,775	634,114	655,137
October	758,779	708,453	690,360	686,184	696,052
November	765,504	678,132	622,543	610,314	612,732
December	712,642	689,869	671,724	643,148	675,871
Total	9,299,403	8,794,662	8,248,158	7,837,948	7,963,282

NEW YORK.

January	95,270	90,027	83,160	64,850	77,029
February	89,526	71,699	73,007	63,080	63,692
March	100,008	101,406	83,226	73,371	70,984
April	96,249	92,245	81,239	79,188	78,771
May	98,490	90,581	88,504	82,035	79,809
June	99,905	92,064	84,442	73,950	73,981
July	96,247	89,457	75,885	75,875	79,091
August	92,900	89,650	81,268	74,663	74,260
September	93,583	86,428	76,263	68,894	74,503
October	90,382	86,659	78,469	76,766	80,424
November	91,058	79,519	70,101	68,045	70,738
December	90,279	84,103	76,761	73,421	78,938
Total	1,134,897	1,053,838	952,515	874,128	902,211

WELL RECORD.

The impetus given by high prices to well drilling in Pennsylvania and New York is forcefully shown in the following table. The total wells drilled increased from 2,472 to 4,251. The increase was seen in every district. There are no statistics of old wells cleaned out or the evidence of activity would be still greater. The average initial daily production per well declined in 1913, as might have been expected from the greater number of wells drilled.

Number of wells completed in the Pennsylvania and New York oil fields, 1909–1913, by districts.

District.	Oil.					Dry.					Total completed.[a]				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Bradford	535	316	260	335	675	36	6	16	14	31	571	344	298	371	755
Allegany	419	219	128	177	441	40	13	9	17	22	459	283	194	246	509
Middle	441	195	208	226	352	65	34	39	36	66	506	235	247	268	435
Venango and Clarion	1,682	635	642	853	1,352	199	70	93	90	141	1,881	790	805	1,019	1,578
Butler and Armstrong	309	152	124	138	354	178	89	65	59	110	487	263	219	216	497
Southwest Pennsylvania	174	156	129	182	246	145	76	75	106	151	319	286	244	354	477
Total	3,560	1,673	1,491	1,911	3,420	[a] 663	[b] 288	[b] 297	[b] 322	[b] 521	4,223	2,201	2,007	2,472	4,251

[a] Including gas wells. [b] Not including gas wells.

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Number of oil wells and dry holes drilled in the Pennsylvania and New York oil fields in 1913, by districts and months.

District.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Bradford	24	1	13	4	43	3	53	2	48	1	85	.....	84	2	54	4
Allegany	18	1	8	1	18	.....	31	1	44	2	46	1	45	3	54	3
Middle	13	3	9	6	14	6	20	9	37	4	41	9	42	5	34	2
Venango and Clarion	64	8	70	7	93	11	104	19	127	8	140	15	124	14	140	15
Butler and Armstrong	20	3	13	5	19	8	18	12	31	7	36	8	30	15	38	20
Southwest Pennsylvania	14	10	16	4	17	8	22	5	16	15	27	16	27	14	24	13
Total	153	26	129	27	204	36	248	48	303	37	375	49	352	53	344	57

District.	Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Bradford	68	6	63	2	79	2	61	4	675	31	335	14
Allegany	43	2	50	4	40	2	44	2	441	22	177	17
Middle	37	6	47	4	31	5	27	7	352	66	226	36
Venango and Clarion	133	16	139	8	121	7	97	13	1,352	141	853	90
Butler and Armstrong	35	7	34	8	54	6	26	11	354	110	138	59
Southwest Pennsylvania	19	19	23	19	16	15	25	13	246	151	182	106
Total	335	56	356	45	341	37	280	50	3,420	521	1,911	322

Number of oil wells drilled in Pennsylvania and New York oil fields, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	268	255	227	317	374	391	359	308	338	215	316	192	3,560
1910	114	94	82	145	213	192	170	158	140	136	146	83	1,673
1911	68	60	52	84	117	152	148	168	170	157	174	141	1,491
1912	73	71	90	150	181	210	191	224	190	190	167	174	1,911
1913	153	129	204	248	303	375	352	344	335	356	341	280	3,420

Number of dry holes drilled in the Pennsylvania and New York oil fields, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	57	43	33	53	62	57	54	76	62	59	52	55	[a] 663
1910	33	38	27	45	53	58	52	53	39	46	42	42	[a] 528
1911	22	25	23	33	33	28	19	32	22	22	25	13	[b] 297
1912	21	11	19	23	30	29	28	42	37	26	37	19	[b] 322
1913	26	27	36	48	37	49	53	57	56	45	37	50	[b] 521

Total number of wells completed in the Pennsylvania and New York oil fields, 1909–1913, by months. [a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	325	298	260	370	436	448	413	384	400	274	368	247	4,223
1910	147	132	109	190	266	250	222	211	179	182	188	125	2,201
1911	100	96	87	120	165	198	191	222	205	210	227	173	2,007
1912	112	91	125	190	232	266	237	284	252	242	228	213	2,472
1913	205	183	268	329	363	439	431	427	416	431	406	353	4,251

[a] Including gas wells. [b] Not including gas wells.

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Initial daily production of new wells completed in New York and Pennsylvania in 1913, by districts and months, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total, 1913.	Total, 1912.
Bradford	62	22	117	151	91	193	196	155	169	150	199	169	1,676	817
Allegany	27	40	42	54	72	73	66	89	91	108	76	82	820	278
Middle	39	14	19	27	63	69	85	60	64	106	49	54	649	511
Venango and Clarion	107	132	168	172	196	247	208	272	204	245	189	161	2,301	1,943
Butler and Armstrong	93	36	79	92	191	173	142	114	136	126	215	90	1,487	696
Southwest Pennsylvania	98	143	308	142	116	204	139	170	162	156	141	246	2,025	2,526
Total	426	387	733	638	729	959	838	860	826	891	869	802	8,958	6,771

Total and average initial daily production of new wells in the Pennsylvania and New York oil fields, 1909–1913, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Bradford	1,345	952	730	817	1,676	2.51	3.01	2.81	2.44	2.48
Allegany	815	368	201	278	820	1.94	1.68	1.57	1.57	1.86
Middle	977	442	541	511	649	2.22	2.27	2.60	2.26	1.84
Venango and Clarion	4,573	1,276	1,302	1,943	2,301	2.72	2.00	2.03	2.28	1.70
Butler and Armstrong	2,493	1,489	422	696	1,487	8.07	9.80	3.40	5.04	4.20
Southwest Pennsylvania	1,130	2,156	1,716	2,526	2,025	6.49	13.82	13.30	13.88	8.23
Total	11,333	6,683	4,912	6,771	8,958	3.18	3.99	3.29	3.54	2.62

Total initial daily production of new wells in the Pennsylvania and New York oil fields, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909	869	785	608	930	1,084	1,027	1,011	1,148	1,046	1,082	991	752	11,333	944
1910	572	320	211	584	1,355	621	604	924	353	395	448	296	6,683	557
1911	204	345	154	313	319	368	435	611	517	507	695	444	4,912	409
1912	548	621	613	657	531	588	482	637	720	530	474	370	6,771	564
1913	426	387	733	638	729	959	838	860	826	891	869	802	8,958	746

WEST VIRGINIA.

DEVELOPMENT.

Petroleum is produced in 26 counties of West Virginia, from Harrison County on the east to the western State line, and from Pennsylvania southwest to Mingo County. This State, which is the home of the anticlinal theory, as developed by Dr. I. C. White, State geologist, possesses ideal structure for the storage of oil over so large an area that many pools have been developed and the drilling of wells yielding as much as 1,000 barrels a day of initial production is still frequent. Conditions are still favorable in the State for the development of new prolific pools that would bring the total yield of the State beyond the maximum. In 1912, for example, the development of the Blue Creek pool, in Kanawha County, increased the total production for that year to 12,128,962 barrels. During the year the pool declined, and a great result in 1913 was not to be expected; nevertheless the total reached 11,567,299 barrels, a loss of only 4.63 per cent. This good

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record was due to the extension of the Blue Creek pool, and chiefly to the increase in Roane County, where the Berea Grit and the Scaffold Run pools, in the Spencer district, developed a product of over 1,000 barrels a day early in the year and increased as the weather became better for drilling. Harrison, Pleasants, Wood, Monongalia, Ritchie, Gilmer, Morgan, and Brooke counties added many gushers yielding from 200 to 1,000 barrels a day.

Although no pool equivalent to the Blue Creek was developed during the year, drilling was more active than ever before, owing to the high prices for oil. The total value increased 44.67 per cent, or from $19,927,721 in 1912 to $28,828,814 in 1913.

PRODUCTION.

In the following table is given the production of petroleum in West Virginia in the years 1909 to 1913, by months:

Total production of petroleum in West Virginia, 1909–1913, by months, in barrels.

Month.	1909	1910	1911	1912	1913
January	735,379	1,026,438	814,743	694,619	978,401
February	722,045	935,252	800,712	801,699	936,733
March	851,002	1,050,163	881,172	983,502	970,900
April	833,432	962,657	810,661	1,018,955	1,026,129
May	829,833	1,001,746	882,063	1,153,945	1,003,425
June	870,909	1,018,694	832,920	1,172,331	995,098
July	904,745	984,813	787,171	1,174,367	1,009,383
August	923,438	1,020,317	838,922	1,190,552	939,479
September	950,188	976,220	773,024	981,052	928,610
October	997,295	935,166	795,687	1,013,980	956,772
November	1,016,738	906,521	757,029	918,313	893,274
December	1,110,088	935,084	821,330	1,025,647	983,095
Total	10,745,092	11,753,071	9,795,464	12,128,962	11,567,299

The quantity and value of petroleum produced in West Virginia from 1904 to 1913, inclusive, are shown in the following table:

Quantity and value of petroleum produced in West Virginia, 1904–1913, in barrels.

Year.	Regular crude.			Lubricating.			Total.		
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.
1904	12,636,253	$20,557,556	$1.627	8,433	$26,225	$3.11	12,644,686	$20,583,781	$1.628
1905	11,573,545	16,117,816	1.393	4,565	14,815	3.25	11,578,110	16,132,631	1.393
1906	10,111,647	16,138,811	1.596	9,288	31,482	3.39	10,120,935	16,170,293	1.598
1907	9,089,839	15,834,714	1.740	5,457	17,714	3.25	9,095,296	15,852,428	1.743
1908	9,519,875	16,902,968	1.775	3,301	8,897	2.70	9,523,176	16,911,865	1.776
1909	10,742,026	17,634,335	1.642	3,066	7,948	2.59	10,745,092	17,642,283	1.642
1910	11,751,018	15,717,796	1.338	2,053	5,748	2.80	11,753,071	15,723,544	1.338
1911	9,792,324	12,757,861	1.302	3,140	9,432	3.00	9,795,464	12,767,293	1.303
1912	12,126,137	19,919,952	1.643	2,825	7,769	2.75	12,128,962	19,927,721	1.643
1913	11,562,730	28,813,822	2.493	4,569	14,982	3.28	11,567,299	28,828,814	2.492

WELL RECORD.

Well drilling was unusually active in West Virginia in 1913, the total number of wells increasing from 1,657 in 1912 to 2,065 in 1913. All counties shared in the increase, except Kanawha, in which the

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Blue Creek excitement of 1912 led to unusual activity in that year, and Calhoun, which was not quite so active in 1913. Mannington district led in the drilling with 526 completed wells.

The total initial production and initial production per well in 1913 declined heavily from 1912, due to lack of any great gusher field comparable with the Blue Creek field in 1912.

Number of wells completed in West Virginia, 1909–1913, by districts.

District.	Oil.					Dry.					Total completed.[a]				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Brooke County	62	7	1	5	28	35	19	2	4	6	97	26	3	9	38
Burning Springs	48	22	22	17	49	12	8	5	3	8	60	30	31	21	60
Cabell County	4	6	1	.....	.....	10	11	2	.....	1	14	17	5	.....	1
Calhoun County	24	11	11	19	18	15	13	2	12	6	39	24	33	38	32
Hancock County	11	5	8	5	21	13	2	.....	11	7	24	7	8	16	33
Kanawha County	.....	.....	(b)	440	177	.....	.....	(b)	11	20	.....	.....	(b)	486	227
Lincoln County	234	133	58	61	66	83	15	3	1	4	317	148	68	70	75
Mannington	202	199	98	80	230	264	301	39	39	51	466	500	280	298	526
Pleasants County	91	97	60	59	108	51	44	29	31	42	142	141	90	91	150
Ritchie County	111	105	93	79	129	52	54	45	20	39	163	159	170	121	191
Roane County	169	188	160	147	253	39	81	8	13	21	208	269	194	169	295
Sistersville	34	7	8	7	16	16	3	9	8	11	50	10	18	15	29
Wetzel and Tyler counties	64	62	35	59	89	73	100	25	40	50	137	162	117	168	213
Wood County	72	44	49	61	71	34	31	31	20	36	106	75	80	81	106
Miscellaneous	8	11	18	23	30	26	37	18	21	37	34	48	94	74	87
Total	1,134	897	622	1,062	1,285	[a] 723	[a] 719	[c] 218	[c] 234	[c] 339	1,857	1,616	1,191	1,657	2,065

[a] Including gas wells. [b] Included in "Miscellaneous." [c] Not including gas wells.

Number of oil wells and dry holes drilled in West Virginia in 1913, by districts and months.

District.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Brooke County	...	...	3	..	..	..	..	..	..	..	..	..	2	1	4	..	6	..	5	2	4	1	4	2	28	6	5	4
Burning Springs	..	..	3	1	3	..	1	1	4	1	4	..	8	..	5	1	2	2	7	1	7	1	5	..	49	8	17	3
Cabell County	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	1	..	..
Calhoun County	1	3	3	..	1	1	1	2	..	2	..	..	..	2	..	..	..	..	2	..	2	1	3	..	18	6	19	12
Hancock County	2	..	1	..	2	..	2	2	3	1	4	1	..	4	1	..	1	..	1	3	..	..	..	..	21	7	5	11
Kanawha County	17	..	18	3	22	4	18	1	21	3	23	4	9	1	8	3	11	..	9	..	13	..	8	1	177	20	440	11
Lincoln County	..	..	4	1	4	..	7	..	4	1	8	..	7	..	8	1	5	..	6	..	8	1	5	..	66	4	61	1
Mannington	9	3	15	3	15	2	19	5	14	2	28	6	12	5	16	4	24	5	25	6	22	4	31	6	230	51	80	39
Pleasants County	5	2	7	3	8	5	12	3	13	4	11	6	8	4	12	1	8	4	10	3	9	2	5	5	108	42	59	31
Ritchie County	12	..	9	1	9	4	10	4	9	3	12	2	16	5	8	2	11	2	11	4	8	6	14	6	129	39	79	20
Roane County	27	..	25	1	14	2	22	3	16	2	23	2	21	2	18	4	21	2	24	1	17	..	25	2	253	21	147	13
Sistersville	...	...	...	1	...	..	1	..	2	..	1	3	1	2	4	1	...	2	3	1	1	..	3	1	16	11	7	8
Wetzel and Tyler counties	9	11	4	6	6	2	12	2	7	6	11	2	11	3	6	5	6	4	10	3	4	5	3	1	89	50	59	40
Wood County	7	2	2	2	5	7	5	3	7	..	5	4	6	5	12	5	8	3	2	1	8	4	4	..	71	36	61	20
Miscellaneous	3	..	4	4	3	3	3	..	1	2	6	4	1	2	3	4	2	5	..	5	3	6	1	2	30	37	23	21
Total	92	21	98	26	91	30	113	25	103	25	138	34	102	30	110	32	104	30	114	28	109	31	111	27	1,285	339	1,062	234

Number of oil wells drilled in West Virginia, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	86	78	87	88	84	102	85	101	117	107	104	95	1,134
1910	100	81	73	69	89	89	81	65	78	70	54	48	897
1911	53	47	52	45	56	44	60	51	50	58	46	60	622
1912	54	50	71	75	74	90	103	113	117	96	111	108	1,062
1913	92	98	91	113	103	138	102	110	104	114	109	111	1,285

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Number of dry holes drilled in West Virginia, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	44	66	56	52	47	53	66	67	65	64	74	69	[a] 723
1910	46	42	49	77	64	68	67	64	59	62	54	67	[a] 719
1911	19	24	21	14	10	12	20	28	19	17	12	22	[b] 218
1912	18	14	30	15	12	11	18	23	21	21	15	36	[b] 234
1913	21	26	30	25	25	34	30	32	30	28	31	27	[b] 339

[a] Including gas wells. [b] Not including gas wells.

Total number of wells completed in West Virginia, 1909–1913, by months.[a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	130	144	143	140	131	155	151	168	182	171	178	164	1,857
1910	146	123	122	146	153	157	148	129	137	132	108	115	1,616
1911	102	108	106	100	96	81	105	107	101	98	80	107	1,191
1912	96	80	119	113	116	134	148	171	185	167	162	166	1,657
1913	157	157	157	177	163	202	163	175	172	187	173	182	2,065

[a] Including gas wells.

Initial daily production of new wells completed in West Virginia, 1913, by districts and months, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total, 1913.	Total 1912.
Brooke County	.....	17	.....	.....	.....	.....	95	242	260	335	210	170	1,329	19
Burning Springs	.....	7	11	2	27	24	34	12	2	28	33	32	212	105
Cabell County	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	.....	12	.....
Calhoun County	20	25	.....	10	30	45	.....	17	.....	20	18	14	199	340
Hancock County	8	2	6	13	15	15	.....	19	.....	.....	4	.....	82	21
Kanawha County	663	1,225	1,143	1,279	963	2,503	467	950	265	490	405	350	10,703	98,870
Lincoln County	.....	80	46	110	95	85	114	77	73	67	111	71	929	1,058
Mannington	248	640	545	791	383	845	214	288	522	853	548	952	6,829	2,001
Pleasants County	310	256	379	128	159	195	120	253	82	75	72	16	2,045	930
Ritchie County	70	46	58	122	77	69	120	58	96	115	42	95	968	726
Roane County	1,775	1,553	805	1,354	470	1,058	407	356	429	281	217	480	9,185	3,161
Sistersville	.....	.....	.....	5	12	10	10	35	.....	17	5	18	112	33
Wetzel and Tyler Counties	272	102	105	236	69	157	229	122	22	167	75	27	1,583	1,254
Wood County	47	10	29	55	55	17	28	91	92	4	41	13	482	318
Miscellaneous	15	25	17	16	5	62	8	7	3	.....	2	5	165	963
Total	3,428	3,988	3,144	4,121	2,360	5,085	1,846	2,527	1,846	2,452	1,795	2,243	34,835	109,804

Total and average initial daily production of new wells in West Virginia, 1909–1913, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Brooke County	182	59	3	19	1,329	19.06	8.43	3.00	3.80	47.46
Burning Springs	183	69	144	105	212	3.81	3.14	6.54	6.18	4.33
Cabell County	24	28	5	(a)	12	6.00	4.67	5.00	.....	.....
Calhoun County	1,084	196	295	340	199	45.17	17.82	26.82	17.90	11.06
Clay County	.....	.....	.....	(a)	(a)	.....	.....	.....	.....	.....
Hancock County	49	7	29	21	82	4.45	1.40	3.63	4.20	3.90
Kanawha County	.....	.....	(a)	98,870	10,703	.....	.....	.....	224.70	60.47
Lincoln County	6,717	2,397	1,067	1,058	929	28.71	18.02	18.74	17.34	14.08
Mannington	24,237	12,426	2,180	2,001	6,829	119.98	62.44	22.24	25.01	29.69
Pleasants County	617	1,050	374	930	2,045	6.78	10.82	6.23	15.76	18.93
Ritchie County	3,326	3,621	1,661	726	968	29.96	34.49	17.86	9.19	7.50
Roane County	3,940	3,966	3,243	3,161	9,185	23.31	21.10	20.27	21.50	36.30
Sistersville	252	141	56	38	112	7.41	20.00	7.00	5.43	2.38
Wetzel and Tyler Counties	1,132	1,752	605	1,254	1,583	17.69	28.26	17.28	21.25	17.79
Wood County	496	402	337	318	482	6.89	9.14	6.88	5.21	6.79
Miscellaneous	225	80	424	963	165	28.13	7.27	23.56	41.87	5.50
Total	43,464	26,194	10,443	109,804	34,835	38.33	29.20	16.79	103.39	27.11

[a] Included in "Miscellaneous."

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Total initial daily production of new wells in West Virginia, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909.....	1,682	1,781	2,221	2,337	1,795	2,656	3,014	3,812	3,615	7,362	4,048	9,141	43,464	3,622
1910.....	4,523	3,559	2,092	2,094	2,085	2,533	1,647	1,500	2,608	1,542	1,408	603	26,194	2,183
1911.....	813	938	773	899	991	767	1,015	834	700	865	1,008	870	10,443	870
1912.....	2,010	6,602	8,577	15,925	19,930	19,926	13,528	6,383	4,586	3,901	2,696	5,740	109,804	9,150
1913.....	3,428	3,988	3,144	4,121	2,360	5,085	1,846	2,527	1,846	2,452	1,795	2,243	34,835	2,903

KENTUCKY

DEVELOPMENT.

The oil output of Kentucky is a little over half that of New York. It comes chiefly from a considerable number of small wells, most of them old, in Wayne County. Within the last few years, however, drilling efforts have been active to extend the West Virginia pools over into Kentucky, with only moderate success in Lawrence County. Other counties near by have shared in this excitement, and some oil has been added to the supply by deepening wells in several eastern counties. Meanwhile oil has been found in the western part of the State as a result of skillful geologic study by J. H. Gardner and others in Ohio County. This has led to much wildcatting in other western counties, more or less carelessly directed and as yet without fully compensating returns.

PRODUCTION.

Increased prices proved stimulating in Kentucky also, and the total production increased from 484,368 barrels in 1912 to 524,568 barrels in 1913, a gain of 8.3 per cent. The total value increased from $424,842 to $675,748, or 59.03 per cent.

Production of petroleum in Kentucky, by months, 1909–1913, in barrels.

Month.	1909	1910	1911	1912	1913
January	59,799	40,984	33,237	38,425	42,074
February	56,355	35,795	31,151	37,723	36,843
March	62,085	41,006	37,910	40,923	39,391
April	55,681	39,907	35,484	37,375	39,036
May	57,065	43,055	42,906	44,967	42,932
June	53,522	44,239	38,509	40,311	39,285
July	55,414	40,009	42,237	44,997	48,211
August	54,777	40,699	44,087	40,866	49,908
September	54,221	41,017	44,356	39,146	52,538
October	46,330	35,822	41,556	38,484	46,301
November	41,772	29,144	40,818	40,000	44,137
December	40,995	37,097	40,207	41,151	43,912
Total	639,016	468,774	472,458	484,368	524,568

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Pipe-line runs in Kentucky in 1912 and 1913, by districts and months, in barrels.

1912.

Month ending—	Cooper and Slickford.	Griffin (Denney).	Mount Pisgah (Sandusky).	Parmleysville.	Steubenville.	Total, Wayne County.	Beaver Creek.	Busseyville.	Campton.
Jan. 27	4,231	7,170	7,377	4,382	1,595	24,755	1,093	.....	1,521
Feb. 24	4,125	9,023	7,390	4,096	2,147	26,781	904	.....	1,024
Mar. 30	5,330	10,053	10,603	4,652	3,246	33,974	1,253	.....	3,895
Apr. 27	4,388	8,994	7,518	3,991	1,890	26,781	844	.....	2,570
May 25	4,278	10,920	6,980	4,057	2,630	28,865	751	.....	3,144
June 29	4,687	16,004	8,453	4,616	2,839	36,599	1,367	.....	3,185
July 27	3,793	14,380	5,805	3,589	2,028	29,595	1,017	.....	2,281
Aug. 31	5,622	14,330	7,574	4,795	2,555	34,876	1,760	.....	3,650
Sept. 28	3,653	11,149	4,507	2,818	1,950	24,077	1,514	.....	2,443
Oct. 26	3,568	13,158	4,434	2,758	1,695	25,613	683	145	1,967
Nov. 30	4,436	15,793	5,227	3,941	2,299	31,696	1,589	1,173	2,953
Dec. 28	4,091	11,737	3,810	2,547	2,030	24,215	1,230	1,166	1,613
Total	52,202	142,711	79,768	46,242	26,904	347,827	14,005	2,484	30,246

Month ending—	Lewis.	Meadow Branch.	Page Hollow.	Ragland.	Stillwater.	Watson.	Williamsburg.	Total.
Jan. 27	.....	223	831	2,634	.....	622	404	32,083
Feb. 24	.....	265	793	3,443	.....	589	138	33,937
Mar. 30	.....	353	.....	4,533	.....	262	.....	44,270
Apr. 27	.....	761	.....	4,306	.....	140	.....	35,402
May 25	.....	523	.....	3,508	.....	325	.....	37,116
June 29	.....	652	1,053	6,758	.....	292	159	50,065
July 27	.....	674	.....	4,687	.....	142	177	38,573
Aug. 31	.....	448	.....	4,558	558	517	.....	46,367
Sept. 28	.....	473	.....	3,438	860	.....	.....	32,805
Oct. 26	.....	564	.....	4,583	917	.....	.....	34,472
Nov. 30	918	604	.....	4,039	1,313	71	159	44,515
Dec. 28	1,698	511	835	4,274	625	.....	.....	36,167
Total	2,616	6,051	3,512	50,761	4,273	2,960	1,037	465,772

1913.

Month ending—	Cooper and Slickford.	Griffin (Denney).	Mount Pisgah (Sandusky).	Parmleysville.	Steubenville.	Total, Wayne County.	Beaver Creek.	Busseyville.	Campton.
Jan. 25	5,298	11,525	3,445	3,016	1,913	25,197	1,469	943	1,695
Feb. 22	4,964	10,815	3,654	2,543	1,824	23,800	1,517	929	2,324
Mar. 29	6,546	14,080	1,519	4,554	1,956	28,655	885	1,296	2,858
Apr. 26	4,324	11,732	.....	5,159	2,239	23,454	1,507	1,170	3,098
May 31	6,663	14,662	.....	7,100	3,295	31,720	1,279	1,229	3,410
June 28	4,675	12,019	.....	4,863	2,482	24,039	970	975	1,978
July 26	5,022	15,479	.....	4,580	2,244	27,325	1,072	957	2,706
Aug. 30	6,124	18,698	.....	5,566	3,235	33,623	1,043	1,542	2,883
Sept. 27	5,109	13,936	.....	4,016	2,525	25,586	1,131	645	2,821
Oct. 25	4,570	12,114	.....	4,195	2,629	23,508	754	1,233	1,894
Nov. 29	6,181	13,708	.....	5,557	2,764	28,210	1,585	1,250	3,035
Dec. 27	4,557	10,157	.....	3,255	2,180	20,149	1,172	515	2,535
Total	64,033	158,925	8,618	54,404	29,286	315,266	14,384	12,684	31,237

Month ending—	Lewis.	Meadow Branch.	Page Hollow.	Ragland.	Stillwater.	Watson.	Williamsburg.	Total.
Jan. 25	1,080	776	572	4,325	712	.....	145	36,914
Feb. 22	4,999	326	.....	2,860	394	208	299	37,656
Mar. 29	3,616	.....	.....	6,100	701	279	298	44,688
Apr. 26	3,494	.....	.....	2,881	1,401	.....	149	37,154
May 31	4,566	.....	.....	4,861	1,318	.....	159	48,542
June 28	2,806	.....	.....	2,896	519	.....	181	34,364
July 26	5,860	.....	.....	3,649	1,084	.....	149	42,802
Aug. 30	11,852	.....	.....	4,232	781	.....	148	56,104
Sept. 27	12,747	.....	.....	3,823	897	.....	149	47,799
Oct. 25	9,401	.....	.....	3,033	1,227	.....	.....	41,050
Nov. 29	11,826	.....	.....	5,002	1,376	.....	.....	52,284
Dec. 27	8,272	.....	.....	3,157	914	.....	.....	36,714
Total	80,519	1,102	572	46,819	11,324	487	1,677	516,071

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WELL RECORD.

In the following tables are given the well records for Kentucky from 1909 to 1913, inclusive:

Number of wells completed in Kentucky, 1909–1913, by counties.

County.	Oil.					Dry.					Total completed.[a]				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Allen	.....	.....	.....	.....	7	.....	.....	.....	.....	1	.....	.....	.....	.....	8
Barren	.....	.....	.....	.....	3	.....	.....	.....	.....	3	.....	.....	.....	.....	6
Cumberland	.....	.....	.....	1	.....	.....	.....	.....	.....	1	.....	.....	.....	1	2
Floyd	.....	.....	2	4	.....	1	.....	1	.....	1	1	.....	3	4	1
Lawrence	.....	2	.....	20	9	1	4	1	12	1	1	6	1	33	11
Logan	.....	7	1	.....	.....	.....	1	.....	.....	.....	.....	8	1	.....	.....
Meade	1	.....	.....	.....	.....	.....	1	.....	.....	.....	1	1	.....	.....	.....
Morgan	.....	.....	.....	.....	32	2	.....	.....	.....	13	2	.....	.....	.....	48
Wayne	86	61	94	75	67	71	38	27	44	31	157	99	121	119	98
Wolfe	5	.....	1	9	12	2	4	.....	2	10	7	4	2	11	22
Other	.....	.....	2	3	3	2	3	4	3	8	2	3	8	10	14
Total	92	70	100	112	133	[a] 79	[b] 51	[b] 33	[b] 61	[b] 69	171	121	136	178	210

[a] Including gas wells. [b] Not including gas wells.

Number of oil wells and dry holes drilled in Kentucky in 1913, by counties and months.

County.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen	...	...	2	1	...	...	...	...	2	...	...	...	...	...	...	...	...	...	2	...	1	...	...	...	7	1	...	...
Barren	...	...	...	...	1	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	2	...	2	...	3	3	...	...
Cumberland	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	1	1	...
Floyd	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	4	...
Lawrence	3	...	1	...	...	...	...	1	...	1	5	...	...	...	2	...	...	...	1	...	...	...	2	...	9	1	20	12
Morgan	1	1	1	2	1	...	3	1	...	1	5	...	1	2	3	2	7	2	4	1	1	...	5	1	32	13	...	...
Wayne	2	2	8	1	2	2	6	5	8	2	3	5	8	3	4	1	11	3	3	1	5	3	7	3	67	31	75	44
Wolfe	...	1	2	...	...	...	1	...	2	1	...	2	2	...	1	2	1	1	1	...	1	1	1	2	12	10	9	2
Other	...	...	1	2	1	1	1	2	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	2	3	8	3	3
Total	6	4	15	7	4	4	11	9	12	4	9	7	11	6	10	5	19	7	11	2	10	4	15	10	133	69	112	61

Number of oil wells drilled in Kentucky, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	10	9	9	12	13	11	8	8	3	3	2	4	92
1910	1	6	3	7	11	9	7	3	4	6	8	5	70
1911	6	14	7	6	11	10	9	8	4	10	9	6	100
1912	10	3	14	10	12	8	6	11	18	6	9	5	112
1913	6	15	4	11	12	9	11	10	19	11	10	15	133

Number of dry holes drilled in Kentucky, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	9	2	8	5	9	7	5	6	5	10	11	2	[a] 79
1910	3	4	.....	4	2	9	10	6	5	5	1	2	[a] 51
1911	4	5	5	2	1	1	6	2	.....	3	1	3	[b] 33
1912	3	1	5	1	3	7	2	7	17	4	7	4	[b] 61
1913	4	7	4	9	4	7	6	5	7	2	4	10	[b] 69

[a] Including gas wells. [b] Not including gas wells.

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Total number of wells completed in Kentucky, 1909–1913, by months.[a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	19	11	17	17	22	18	13	14	8	13	13	6	171
1910	4	10	3	11	13	18	17	9	9	11	9	7	121
1911	7	20	12	8	12	10	14	10	9	13	12	9	136
1912	13	6	19	11	16	15	8	18	37	10	16	9	178
1913	11	23	9	21	17	16	18	17	26	13	14	25	210

[a] Including gas wells.

Initial production of new wells completed in Kentucky in 1913, by counties and months, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total, 1913.	Total, 1912.
Allen	.....	45	.....	.....	22	.....	.....	.....	.....	22	25	.....	114	.....
Barren	.....	.....	.....	.....	.....	8	.....	.....	.....	.....	6	.....	14	.....
Lawrence	31	10	.....	.....	.....	.....	.....	11	.....	5	.....	8	65	148
Morgan	2	100	40	330	5	70	15	125	125	32	20	103	967	.....
Wayne	10	64	15	46	59	60	186	22	62	61	53	85	723	1,481
Wolfe	.....	6	.....	50	7	.....	20	8	5	4	5	2	107	196
Other	.....	100	50	75	.....	.....	.....	.....	.....	.....	.....	.....	225	118
Total	43	325	105	501	93	138	221	166	192	124	109	198	2,215	1,943

Total and average initial daily production of new wells in Kentucky, 1909–1913, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Allen	.....	.....	.....	.....	114	.....	.....	.....	.....	16.28
Barren	.....	.....	.....	.....	14	.....	.....	.....	.....	4.66
Cumberland	.....	.....	.....	3	.....	.....	.....	.....	3.0	.....
Floyd	.....	.....	45	35	.....	.....	.....	22.5	8.8	.....
Lawrence	.....	17	.....	148	65	.....	8.5	.....	7.4	7.22
Logan	.....	65	10	.....	.....	.....	9.3	10.0	.....	.....
Meade	25	.....	.....	.....	.....	25.0	.....	.....	.....	.....
Morgan	.....	.....	.....	.....	967	.....	.....	.....	.....	30.22
Wayne	2,111	747	1,729	1,481	723	24.5	12.2	18.4	19.7	10.79
Wolfe	50	.....	25	196	107	10.0	.....	25.0	21.8	8.92
Other	.....	.....	13	80	225	.....	.....	6.5	26.7	75.00
Total	2,186	829	1,822	1,943	2,215	23.8	11.8	18.2	17.3	16.65

Total initial daily production of new wells in Kentucky, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909	214	128	215	100	277	177	155	502	78	10	105	225	2,186	182
1910	15	110	50	73	149	97	69	60	33	54	81	38	829	69
1911	17	93	101	167	176	89	195	227	358	129	125	145	1,822	152
1912	122	35	341	255	216	255	112	213	121	128	75	70	1,943	162
1913	43	325	105	501	93	138	221	166	192	124	109	198	2,215	185

TENNESSEE.

There was no commercial production of petroleum in Tennessee, but considerable interest in the prospects continued to be manifested in the neighborhood of Franklin. The conditions of occurrence of oil and gas in Tennessee are well described by George H. Ashley in "The Resources of Tennessee," vol. 2, No. 7.

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OHIO.

DEVELOPMENT.

Interest in oil development in Ohio was almost entirely confined to the eastern and central parts of the State, where drilling was most active in Washington, Perry, Morgan, Licking, Monroe, Hocking, Ashland, and Noble counties. No considerable pools were developed, and in spite of a drilling campaign skillfully planned and carried out with great energy by the larger companies, the production declined from 8,969,007 barrels in 1912 to 8,781,468 barrels in 1913, or 2.09 per cent. Both the Lima district and the southeastern district shared the decline, which amounted to 48,685 barrels in the southeastern and to 138,854 barrels in the Lima district. The average price for the two districts increased from $1.35 in 1912 to $2 in 1913, and the value of the State's total product increased 45.1 per cent, or from $12,085,998 to $17,538,452.

Production of petroleum in Ohio in 1909–1913, by months and districts, in barrels.

Month.	Lima.				
	1909	1910	1911	1912	1913
January	520,146	430,261	395,132	254,382	336,665
February	469,111	389,171	364,706	245,764	275,831
March	566,455	488,017	413,321	316,946	279,117
April	524,356	444,837	380,434	366,846	349,204
May	518,656	443,865	406,705	380,394	333,866
June	515,396	436,721	393,385	354,165	317,476
July	512,017	416,649	367,216	365,227	327,556
August	488,034	436,568	383,440	358,260	319,486
September	470,970	407,103	365,586	322,245	319,443
October	467,788	400,640	376,118	353,881	332,992
November	457,845	397,553	330,800	313,361	296,090
December	404,583	402,751	360,032	[a] 324,426	329,317
Total	5,915,357	5,094,136	4,535,875	[a] 3,955,897	3,817,043

Month.	Southeastern Ohio.				
	1909	1910	1911	1912	1913
January	339,951	395,160	346,170	333,489	407,538
February	333,792	355,016	341,747	356,983	364,307
March	401,063	451,068	372,270	443,795	324,699
April	388,865	435,057	345,162	440,834	456,072
May	390,884	454,628	383,774	453,807	420,757
June	376,480	436,580	371,118	416,396	414,698
July	457,921	401,193	341,329	439,748	424,588
August	414,599	412,014	364,138	460,361	410,459
September	415,325	384,210	352,353	410,131	425,023
October	417,112	382,105	358,100	437,877	456,364
November	406,158	353,519	343,691	397,129	406,018
December	375,266	361,684	361,385	422,560	453,902
Total	4,717,436	4,822,234	4,281,237	5,018,110	4,964,425

Month.	Total.				
	1909	1910	1911	1912	1913
January	860,097	825,421	741,302	587,871	744,203
February	802,903	744,187	706,453	602,747	640,138
March	967,538	939,085	785,591	760,741	603,816
April	913,221	879,894	725,596	807,680	805,276
May	909,540	898,493	789,479	834,201	754,623
June	891,876	873,301	764,503	770,561	732,174
July	969,938	817,842	708,545	804,975	752,144
August	902,633	848,582	747,578	818,621	729,945
September	886,295	791,313	717,939	732,376	744,466
October	884,900	782,745	734,218	791,758	789,356
November	864,003	751,072	674,491	710,490	702,108
December	779,849	764,435	721,417	746,986	783,219
Total	10,632,793	9,916,370	8,817,112	8,969,007	8,781,468

[a] Includes production of Michigan.

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The quantity and value of petroleum produced in Ohio from 1904 to 1913, inclusive, by districts, are shown in the following table:

Quantity, value, and average price per barrel of petroleum produced in Ohio, 1904–1913, by districts, in barrels.

Year.	Lima.		Average price per barrel.	Southeastern Ohio.		Average price per barrel.	Total.		Average price per barrel.
	Quantity.	Value.		Quantity.	Value.		Quantity.	Value.	
1904....	13,350,060	$14,735,129	$1.103	5,526,571	$8,995,386	$1.627	18,876,631	$23,730,515	$1.257
1905....	11,329,924	10,061,902	.888	5,016,736	6,992,885	1.393	16,346,660	17,054,877	1.043
1906....	9,881,184	9,157,641	.926	4,906,579	7,839,359	1.597	14,787,763	16,997,000	1.149
1907....	7,993,057	7,425,480	.929	4,214,391	7,344,408	1.742	12,207,448	14,769,888	1.209
1908....	6,748,676	6,861,885	1.016	4,110,121	7,316,617	1.780	10,858,797	14,178,502	1.305
1909....	5,915,357	5,451,497	.921	4,717,436	7,773,880	1.647	10,632,793	13,225,377	1.243
1910....	5,094,136	4,181,639	.821	4,822,234	6,469,939	1.341	9,916,370	10,651,568	1.074
1911....	4,535,875	3,888,119	.857	4,281,237	5,591,423	1.306	8,817,112	9,479,542	1.075
1912....	[a] 3,955,897	3,908,809	.988	5,013,110	8,177,189	1.628	8,969,007	12,085,998	1.347
1913....	3,817,043	5,308,842	1.391	4,904,425	12,229,610	2.463	8,781,468	17,538,452	1.997

[a] Includes production of Michigan.

WELL RECORD.

The increased drilling activity in 1913 was represented in central and southern Ohio by 2,191 wells completed, compared with 1,717 wells in 1912 and 1,680 wells in 1911. The proportion of producing wells to dry holes was satisfactory, but the initial daily production declined in 1913.

In the Lima region drilling was more active in all the larger counties, resulting in a total of 972 wells completed in 1913, against 551 in 1912. The initial production per well showed only a slight decline, and about equaled the average of the last five years.

Number of wells completed in central and southeastern Ohio, 1911–1913, by counties.

County.	Oil.			Dry.			Total completed.[a]		
	1911	1912	1913	1911	1912	1913	1911	1912	1913
Ashland	.....	.....	1	12	34	21	100	131	118
Athens	.....	3	15	.....	5	12	.....	10	28
Belmont	.....	9	21	.....	3	29	.....	13	58
Carroll	10	5	21	20	5	22	36	11	44
Columbiana	14	4	28	30	13	18	44	17	47
Coshocton	7	9	15	7	1	.....	17	10	18
Cuyahoga	1	4	.....	.....	4	1	2	19	1
Delaware	.....	.....	.....	1	.....	.....	1	.....	.....
Erie	.....	.....	.....	.....	.....	.....	1	.....	.....
Fairfield	57	25	44	35	19	28	115	60	91
Guernsey	.....	.....	11	.....	.....	22	.....	.....	33
Harrison	10	11	19	4	7	10	17	23	29
Hocking	38	74	178	12	12	30	92	129	137
Holmes	.....	.....	1	3	.....	2	4	.....	3
Jackson	.....	.....	.....	1	.....	.....	1	.....	.....
Jefferson	28	30	60	31	19	22	79	57	83
Knox	.....	.....	1	11	12	8	44	53	24
Lake	.....	.....	.....	.....	.....	.....	.....	1	.....
Licking	6	37	38	34	35	26	164	169	144
Lorain	1	1	1	2	13	5	6	19	8
Madison	.....	.....	.....	.....	1	.....	.....	1	.....
Medina	1	.....	.....	4	5	8	14	23	28
Monroe	43	70	100	42	24	31	98	102	137
Morgan	117	118	142	55	78	50	172	196	192
Muskingum	9	18	21	12	11	8	28	30	33
Noble	95	19	62	62	21	37	163	43	101
Perry	[b] 107	188	172	[b] 31	23	40	[b] 140	219	220

[a] Includes gas wells.

[b] Includes Athens County.

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Number of wells completed in central and southeastern Ohio, 1911–1913, by counties—Continued.

County.	Oil.			Dry.			Total completed.		
	1911	1912	1913	1911	1912	1913	1911	1912	1913
Richland	.....	.....	.....	1	4	8	3	21	31
Ross	1	.....	.....	.....	.....	.....	1	.....	.....
Summit	.....	.....	.....	.....	2	2	.....	3	2
Tuscarawas	.....	.....	.....	.....	2	1	.....	2	1
Vinton	4	1	.....	2	1	.....	8	5	.....
Washington	215	206	370	98	94	151	324	303	533
Wayne	1	14	25	2	12	11	6	47	47
Total	765	846	1,246	512	460	603	1,680	1,717	2,191

Number of oil wells and dry holes drilled in central and southeastern Ohio in 1913, by counties and months.

County.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Ashland (Ashland, Greene, Mifflin, Milton, Montgomery, Perry, and Vermilion districts)	....	1	....	2	....	....	....	....	....	1	....	2	....	1
Athens	1	....	....	....	3	....	....	1	....	....	2	....	....	....
Belmont	1	2	2	7	1	4	4	2	1	....	1	3	2	1
Carroll	2	3	2	3	2	....	....	....	....	....	....	1	1	....
Columbiana (Alliance district)	1	2	....	2	1	3	2	....	3	....	8	5	....	....
Coshocton (Bedford and Pike districts)	....	....	....	....	....	....	....	....	....	....	3	....	1	....
Cuyahoga (Cleveland and Newburg districts)	....	....	....	....	....	....	....	....	....	1	....	....	....	....
Fairfield (Berne, Liberty, Richland, and Walnut districts)	2	2	1	1	4	4	4	2	4	3	....	....	8	6
Guernsey	....	....	....	....	....	....	....	....	....	2	5	3	2	3
Harrison (Plum Run district)	2	....	1	....	2	....	1	1	2	2	2	....	2	4
Hocking (Falls, Gore, Greene, Good Hope, Laurel, Perry, Salt Creek, Starr, and Ward districts)	4	3	5	4	8	....	6	....	7	1	5	....	4	6
Holmes (Richland district)	....	1	....	....	....	....	....	....	....	....	....	....	1	1
Jefferson (Amsterdam and Steubenville districts)	3	1	1	....	8	1	7	6	6	2	1	2	5	2
Knox (Brown, Clay, Clinton, College, Jefferson, Morgan, Pleasant, and Pike districts)	....	3	....	3	....	....	....	....	....	....	....	....	....	....
Licking (Bowling Green, Franklin, Granville, Hanover, Harrison, Hopewell, Liberty, McKean, Madison, Newark, Newton, Perry, St. Albans, Union, and Washington districts)	6	7	4	2	....	1	4	....	6	4	4	2	2	1
Lorain (Avon, Pittsfield, and Russia districts)	....	2	....	1	1	....	....	....	....	....	....	....	....	....
Medina (Harrisville, Homer, Medina, Westfield, and York districts)	....	....	....	1	....	1	....	1	....	....	....	....	....	....
Monroe (Graysville, Jackson Ridge, New Castle, Rinard Mills, Trail Run, and Woodsfield districts)	6	....	8	1	5	3	7	4	15	4	4	2	7	2
Morgan (Chester Hill district)	3	3	7	3	3	3	18	2	14	5	3	4	17	6
Muskingum (Bethlehem, Hopewell, Newton, and Washington districts)	1	1	4	3	3	....	1	....	3	....	1	1	2	1
Noble	1	1	5	1	5	3	8	7	5	2	12	3	1	2
Perry (Harrison, Madison, and Pike districts)	8	1	15	6	13	3	7	3	12	2	15	4	17	....
Richland (Madison, Monroe, and Worthington districts)	....	3	....	2	....	1	....	....	....	....	....	....	....	....
Summit (Franklin and Northfield districts)	....	....	....	....	....	....	....	....	....	2	....	....	....	....
Tuscarawas (Rush district)	....	....	....	....	....	....	....	....	....	1	....	....	....	....
Washington (Macksburg, Marietta, and New Matamoras districts)	24	8	20	9	34	8	24	15	44	11	43	17	26	14
Wayne (Baughman, Chester, Congress, Franklin, Green, Milton, and Wooster districts)	1	1	1	....	2	1	1	....	1	3	1	....	6	....
Total	66	45	76	51	95	36	94	44	123	46	110	49	104	50

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Number of oil wells and dry holes drilled in central and southeastern Ohio in 1913, by counties and months—Continued.

County.	Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Ashland (Ashland, Greene, Mifflin, Milton, Montgomery, Perry, and Vermilion districts)	....	3	....	4	....	....	....	5	1	2	1	21	....	34
Athens	3	1	4	2	....	2	1	2	1	4	15	12	3	5
Belmont	1	....	1	2	2	3	3	3	2	2	21	29	9	3
Carroll	5	3	2	5	1	4	2	2	4	1	21	22	5	5
Columbiana (Alliance district)	6	2	2	1	4	1	1	2	....	....	28	18	4	13
Coshocton (Bedford and Pike districts)	....	....	1	....	8	....	....	....	2	....	15	....	9	1
Cuyahoga (Cleveland and Newburg districts)	....	....	....	....	....	....	....	....	....	....	....	1	4	4
Fairfield (Berne, Liberty, Richland, and Walnut districts)	6	....	4	3	5	1	3	4	3	2	44	28	25	19
Guernsey	4	4	....	2	....	4	....	....	....	4	11	22	11	7
Harrison (Plum Run district)	....	....	2	1	3	1	2	....	....	1	19	10	74	12
Hocking (Falls, Gore, Greene, Good Hope, Laurel, Perry, Salt Creek, Starr, and Ward districts)	10	3	6	2	11	1	9	4	3	6	78	30	....	....
Holmes (Richland district)	....	....	....	....	....	....	....	....	....	....	1	2	....	....
Jefferson (Amsterdam and Steubenville districts)	6	....	7	4	3	2	5	....	8	2	60	22	30	19
Knox (Brown, Clay, Clinton, College, Jefferson, Morgan, Pleasant, and Pike districts)	....	1	....	....	....	1	....	....	1	....	1	8	....	12
Licking (Bowling Green, Franklin, Granville, Hanover, Harrison, Hopewell, Liberty, McKean, Madison, Newark, Newton, Perry, St. Albans, Union, and Washington districts)	4	2	1	1	1	....	4	3	2	3	38	26	37	35
Lorain (Avon, Pittsfield, and Russia districts)	....	1	....	....	....	1	....	....	....	....	1	5	1	13
Madison	....	....	....	....	....	....	....	....	....	....	....	....	....	1
Medina (Harrisville, Homer, Medina, Westfield, and York districts)	....	1	....	2	....	2	....	....	....	....	....	8	....	5
Monroe (Graysville, Jackson Ridge, New Castle, Rinard Mills, Trail Run, and Woodsfield districts)	11	6	7	2	12	3	11	....	7	4	100	31	70	24
Morgan (Chester Hill district)	10	5	23	6	16	3	8	3	20	7	142	50	118	78
Muskingum (Bethlehem, Hopewell, Newton, and Washington districts)	2	2	1	....	1	....	2	....	....	....	21	8	18	11
Noble	1	2	8	2	5	7	3	1	8	6	62	37	19	21
Perry (Harrison, Madison, and Pike districts)	18	5	20	3	15	5	19	6	13	2	172	40	188	23
Richland (Madison, Monroe, and Worthington districts)	....	....	....	1	....	....	....	1	....	....	....	8	....	
Summit (Franklin and Northfield districts)	....	....	....	....	....	....	....	....	....	....	....	2	....	2
Tuscarawas (Rush district)	....	....	....	....	....	....	....	....	....	....	....	1	....	2
Vinton	....	....	....	....	....	....	....	....	....	....	....	....	1	1
Washington (Macksburg, Marietta, and New Matamoras districts)	42	19	29	4	31	16	30	12	23	18	370	151	206	94
Wayne (Baughman, Chester, Congress, Franklin, Green, Milton, and Wooster districts)	2	1	4	2	2	....	2	1	2	2	25	11	14	12
Total	131	61	122	49	120	57	105	49	100	66	1,246	603	846	460

Number of oil wells drilled in central and southeastern Ohio, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	88	83	86	112	128	160	159	150	134	126	123	111	1,460
1910	62	71	93	86	89	108	96	76	85	58	71	58	953
1911	61	59	57	61	65	71	57	61	66	67	71	69	765
1912	45	49	48	65	79	89	86	81	71	94	65	74	846
1913	66	76	95	94	123	110	104	131	122	120	105	100	1,246

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Number of dry holes drilled in central and southeastern Ohio, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	57	54	64	67	53	72	91	90	82	53	78	59	[a] 820
1910	43	33	49	57	53	67	54	44	79	62	59	95	[a] 686
1911	36	32	41	33	38	50	56	53	36	48	45	44	[b] 512
1912	31	17	28	26	33	32	50	49	65	51	41	37	[b] 460
1913	45	51	36	44	46	49	50	61	49	57	49	66	[b] 603

[a] Including gas wells. [b] Not including gas wells.

Total number of wells completed in central and southeastern Ohio, 1909–1913, by months.[a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	145	137	150	179	181	232	250	240	216	179	201	170	2,280
1910	105	104	142	143	142	175	150	120	155	120	130	153	1,639
1911	138	121	121	114	129	151	149	133	144	162	172	146	1,680
1912	90	83	97	113	127	158	177	163	196	203	156	154	1,717
1913	140	165	151	148	184	172	174	227	200	224	200	206	2,191

[a] Including gas wells.

Initial daily production of new wells completed in central and southeastern Ohio in 1913, by counties and months, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total. 1913.	Total 1912.
Ashland	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20	20	.....
Athens	1	.....	7	.....	.....	5	.....	8	14	.....	2	2	39	8
Belmont	150	25	2	121	75	5	45	2	60	87	126	12	710	553
Carroll	5	8	13	.....	.....	.....	3	9	10	5	5	4	62	14
Columbiana	2	.....	3	3	11	54	.....	12	5	13	2	.....	105	21
Coshocton	.....	.....	.....	.....	.....	35	2	.....	20	91	.....	4	152	86
Cuyahoga	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	45
Fairfield	18	25	112	80	100	.....	230	240	55	90	235	42	1,227	494
Guernsey	.....	.....	.....	.....	.....	9	28	8	.....	.....	.....	.....	45	.....
Harrison	4	5	10	5	8	15	4	.....	10	17	8	.....	86	59
Hocking	125	310	420	275	195	150	215	408	310	655	480	95	3,638	2,986
Holmes	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	2	.....
Jefferson	12	2	26	23	20	2	14	22	27	9	24	37	218	135
Knox	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10	10	.....
Licking	130	70	.....	60	165	60	55	60	10	7	80	160	857	734
Lorain	.....	.....	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	15	10
Monroe	51	32	75	67	104	52	123	106	42	118	94	48	912	784
Morgan	17	44	11	57	36	9	68	30	44	37	36	65	454	781
Muskingum	20	32	7	2	7	5	7	13	1	1	12	.....	107	393
Noble	1	31	87	50	33	31	2	5	21	11	7	39	318	93
Perry	168	411	272	145	352	623	348	397	663	795	465	146	4,785	15,117
Vinton	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
Washington	117	111	121	85	172	202	146	194	117	164	143	104	1,676	1,290
Wayne	50	10	60	50	50	25	215	95	150	59	65	35	864	585
Total	871	1,116	1,241	1,023	1,328	1,282	1,507	1,609	1,559	2,159	1,784	823	16,302	24,193

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Total and average initial daily production of new wells in central and southeastern Ohio, 1911–1913, by counties, in barrels.

County.	Total initial production.			Average initial production per well.		
	1911	1912	1913	1911	1912	1913
Ashland	.....	.....	20	.....	.....	20.00
Athens	.....	8	39	.....	2.66	2.60
Belmont	.....	553	710	.....	61.44	33.81
Carroll	80	14	62	8.00	2.80	2.95
Columbiana	69	21	105	4.93	5.25	3.75
Coshocton	100	86	152	14.29	9.55	10.13
Cuyahoga	10	45	.....	10.00	11.25	.....
Fairfield	1,040	494	1,227	18.25	19.76	27.89
Guernsey	.....	.....	45	.....	.....	4.09
Harrison	35	59	86	3.50	5.36	4.53
Hocking	1,386	2,986	3,638	36.47	40.35	46.64
Holmes	.....	.....	2	.....	.....	2.00
Jefferson	91	135	218	3.25	4.50	3.63
Knox	.....	.....	10	.....	.....	10.00
Licking	143	734	857	2.38	19.84	22.55
Lorain	10	10	15	10.00	10.00	15.00
Medina	35	.....	.....	35.00	.....	.....
Monroe	393	784	912	9.14	11.20	9.12
Morgan	1,488	781	454	12.72	6.62	3.20
Muskingum	228	393	107	25.33	21.83	5.09
Noble	325	93	318	3.42	4.89	5.13
Perry	[a] 3,681	15,117	4,785	34.40	83.98	27.82
Ross	5	.....	.....	5.00	.....	.....
Summit	.....	.....	.....	.....	.....	.....
Vinton	77	5	.....	19.25	5.00	.....
Washington	1,702	1,290	1,676	7.91	6.26	4.53
Wayne	25	585	864	25.00	41.78	34.56
Total	10,923	24,193	16,302	14.28	28.60	13.08

[a] Includes Athens County.

Total initial daily production of new wells in central and southeastern Ohio, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909	2,054	2,490	1,739	1,794	2,490	3,652	2,629	2,131	1,737	2,206	1,971	1,259	26,152	2,179
1910	1,319	1,440	2,388	2,747	2,314	2,065	1,296	872	1,055	1,195	783	642	18,116	1,510
1911	882	973	666	687	1,222	709	577	772	895	916	1,526	1,098	10,923	910
1912	1,737	3,577	1,992	1,944	2,309	2,067	2,077	2,518	1,039	2,199	1,006	1,728	24,193	2,016
1913	871	1,116	1,241	1,023	1,328	1,282	1,507	1,609	1,559	2,159	1,784	823	16,302	1,359

In the following tables are given the well records for the Lima (Ohio) oil field from 1909 to 1913, inclusive:

Number of wells completed in the Lima (Ohio) district, 1909–1913, by counties.

County.	Oil.					Dry.					Total completed.[a]				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Allen	75	12	21	54	138	4	1	.....	2	5	79	13	21	56	143
Auglaize	11	17	12	7	19	4	5	4	4	7	15	22	18	11	27
Hancock	106	114	104	101	172	5	8	2	7	20	111	125	113	116	193
Hardin	.....	2	2	.....	.....	.....	.....	.....	.....	.....	.....	5	2	.....	.....
Henry	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....
Lucas	21	7	21	18	29	.....	.....	1	2	8	21	7	22	21	37
Mercer	5	4	9	11	40	1	1	2	1	5	6	5	12	12	45
Ottawa	53	23	14	7	24	4	1	3	2	3	57	25	18	9	29
Putnam	.....	1	2	.....	2	.....	.....	.....	.....	.....	.....	1	2	.....	2
Sandusky	107	64	56	53	104	9	5	2	8	5	116	71	58	62	109
Seneca	71	47	35	29	35	12	7	8	9	7	83	54	44	40	43
Van Wert	75	18	28	19	38	8	2	1	1	4	83	20	24	21	42
Wood	253	189	179	177	271	29	26	9	18	23	282	217	191	196	298
Wyandot	9	3	2	4	1	.....	1	.....	.....	2	9	5	2	4	3
Miscellaneous	.....	.....	.....	2	.....	9	.....	.....	1	1	9	2	.....	3	1
Total	787	501	490	482	873	[a] 85	[b] 57	[b] 32	[b] 55	[b] 90	872	572	527	551	972

[a] Including gas wells. [b] Not including gas wells.

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Number of oil wells and dry holes drilled in the Lima (Ohio) district in 1913, by counties and months.

County.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen	13	..	3	..	10	1	5	..	8	..	12	1	17	..	16	2	14	..	14	1	14	..	12	..	138	5	54	2
Auglaize	1	..	..	..	1	2	2	1	1	..	3	1	3	..	1	2	2	1	1	..	2	..	2	..	19	7	7	4
Hancock	10	..	8	1	7	3	9	3	14	..	15	1	17	1	24	1	14	5	18	3	18	..	18	2	172	20	101	7
Lucas	..	..	2	1	2	..	1	2	1	1	4	1	3	..	3	2	4	1	2	..	3	..	4	..	29	8	18	2
Mercer	2	1	2	..	1	1	1	2	2	1	5	..	6	..	5	..	5	..	4	..	3	..	4	..	40	5	11	1
Ottawa	..	..	1	..	1	..	..	..	4	..	3	..	2	1	5	1	2	..	1	..	3	1	2	..	24	3	7	2
Putnam	1	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	2	..	..	..
Sandusky	3	..	6	..	9	1	6	..	7	1	12	..	12	..	8	1	10	1	8	..	12	1	11	..	104	5	53	8
Seneca	4	..	2	..	3	..	3	2	2	1	2	..	4	1	4	3	2	..	3	..	4	..	2	..	35	7	29	9
Van Wert	2	..	1	..	4	..	1	..	7	..	..	..	4	2	3	..	4	1	6	1	4	..	2	..	38	4	19	1
Wood	12	2	14	1	19	..	13	..	24	3	17	2	29	1	32	4	26	4	31	3	23	2	31	1	271	23	177	18
Wyandot	..	1	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1	1	2	4	..	..
Miscellaneous	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	2	1	..
Total	48	4	39	3	57	8	41	10	70	8	73	6	98	6	102	16	83	13	88	8	86	4	88	4	873	90	482	55

Number of oil wells drilled in Lima (Ohio) district, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	89	55	67	80	64	85	68	71	66	58	49	35	787
1910	24	24	26	40	46	50	52	51	48	38	63	39	501
1911	40	42	38	38	39	41	39	42	48	41	42	30	480
1912	15	17	22	31	43	44	43	46	54	43	62	62	482
1913	48	39	57	41	70	73	98	102	83	88	86	88	873

Number of dry holes drilled in the Lima (Ohio) district, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	9	4	11	6	6	7	4	7	5	6	14	6	[a] 85
1910	5	2	4	4	6	6	7	5	5	4	5	4	[b] 57
1911	3	4	1	.....	4	5	4	3	.....	2	4	2	[b] 32
1912	1	1	4	3	5	5	5	7	10	5	7	2	[b] 55
1913	4	3	8	10	8	6	6	16	13	8	4	4	[b] 90

[a] Including gas wells. [b] Not including gas wells.

Total number of wells completed in the Lima (Ohio) district, 1909–1913, by months. [a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	98	59	78	86	70	92	72	78	71	64	63	41	872
1910	29	27	31	46	55	57	59	56	54	44	69	45	572
1911	45	48	40	40	44	48	42	46	50	44	47	33	527
1912	18	20	28	34	50	49	48	53	66	48	71	66	551
1913	53	43	65	52	78	80	107	119	96	96	90	93	972

[a] Including gas wells.

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Initial daily production of new wells completed in the Lima (Ohio) district in 1913, by counties and months, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total, 1913.	Total, 1912.
Allen	177	35	109	65	110	217	234	229	185	112	215	195	1,883	699
Auglaize	10	.....	10	20	3	22	12	5	6	15	24	15	142	47
Hancock	188	125	82	103	221	403	258	446	222	300	376	200	2,924	1,379
Lucas	.....	12	30	1	10	85	30	17	53	45	50	40	373	172
Mercer	10	45	10	20	70	40	75	90	63	40	35	75	573	111
Ottawa	.....	5	10	.....	22	25	25	21	10	5	18	7	148	36
Putnam	2	.....	.....	.....	.....	.....	.....	5	.....	.....	.....	.....	7	.....
Sandusky	20	28	48	46	52	56	59	30	77	46	86	77	625	266
Seneca	200	10	116	130	15	25	85	39	10	22	46	15	713	1,041
Van Wert	15	10	16	5	102	.....	30	55	33	40	58	15	379	272
Wood	87	169	168	242	266	333	425	477	239	298	314	386	3,404	3,153
Wyandot	.....	.....	.....	.....	.....	.....	10	.....	.....	.....	.....	.....	10	37
Miscellaneous	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
Total	709	439	599	632	871	1,206	1,243	1,414	898	923	1,222	1,025	11,181	7,229

Total and average initial daily production of new wells in the Lima (Ohio) district, 1909–1913, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Allen	708	110	171	699	1,883	9.4	9.2	8.1	12.9	13.6
Auglaize	138	306	174	47	142	12.5	18.0	14.5	6.7	7.5
Hancock	1,253	1,505	1,546	1,379	2,924	11.8	13.2	14.9	13.7	17.0
Hardin	.....	13	25	.....	.....	.....	6.5	12.5	.....	.....
Henry	5	.....	.....	.....	.....	5.0	.....	.....	.....	.....
Lucas	203	116	412	172	373	9.7	16.6	19.6	9.5	12.9
Mercer	35	65	60	111	573	7.0	16.3	6.7	10.1	14.4
Ottawa	450	183	108	36	148	8.5	8.0	7.7	5.1	6.2
Putnam	.....	3	12	.....	7	.....	3.0	6.0	.....	3.5
Sandusky	561	422	312	266	625	5.2	6.6	5.6	5.0	6.0
Seneca	582	737	341	1,041	713	8.2	15.7	9.7	35.9	20.4
Van Wert	639	192	369	272	379	8.5	10.7	16.0	14.3	10.0
Wood	3,423	3,003	2,836	3,153	3,404	13.5	15.9	15.8	17.8	12.6
Wyandot	121	90	15	37	10	13.4	30.0	7.5	9.3	10.0
Miscellaneous	.....	.....	.....	16	.....	.....	.....	.....	8.0	.....
Total	8,118	6,745	6,381	7,229	11,181	10.3	13.5	13.3	15.0	12.8

Total initial daily production of new wells in the Lima (Ohio) district, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909	1,067	767	567	678	480	900	606	853	626	718	513	343	8,118	677
1910	377	425	500	530	565	447	684	735	794	441	723	524	6,745	562
1911	508	599	323	483	460	559	498	630	470	793	465	593	6,381	532
1912	192	221	983	440	619	767	643	781	743	463	839	538	7,229	602
1913	709	439	599	632	871	1,206	1,243	1,414	898	923	1,222	1,025	11,181	932

LIMA-INDIANA FIELD.

PRODUCTION.

Production has been declining in the Lima-Indiana field continuously since 1904. The rate of decline has varied within considerable limits, but in general it has been rapid. The decline in 1912 as compared with 1911 was 20.95 per cent. The general trend of higher prices for crude petroleum in the United States included the Lima-Indiana field, however, and raised the average price from $0.932 in 1912 to $1.38 in 1913. Naturally, this stimulated drilling to such an

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extent that the decline was almost halted, and amounted to only 3.1 per cent.

Production of petroleum in the Lima-Indiana field in 1912 and 1913, by months, in barrels.

Month.	1912			1913		
	Lima, Ohio.	Indiana.	Total.	Lima, Ohio.	Indiana.	Total.
January	254,382	64,403	318,785	336,665	73,237	409,902
February	245,764	62,991	308,755	275,831	70,336	346,167
March	316,946	81,148	398,094	279,117	57,204	336,321
April	366,846	92,965	459,811	349,204	78,764	427,768
May	380,394	101,102	481,496	333,866	77,379	411,245
June	354,165	85,819	439,984	317,476	73,056	390,532
July	365,227	90,011	455,238	327,556	73,838	401,394
August	358,260	86,492	444,752	319,486	72,467	391,953
September	322,245	78,432	400,677	319,443	81,462	400,905
October	353,881	83,634	437,515	332,992	91,368	424,360
November	313,361	69,733	383,094	296,090	98,444	394,534
December	[a] 324,426	73,279	397,705	329,317	108,540	437,857
Total	[a] 3,955,997	970,009	4,925,906	3,817,043	956,095	4,773,138

[a] Includes production of Michigan.

The history of the field is given in concise form in the following table, which shows that the field opened commercially in 1886 with a production of a little over 1,000,000 barrels, or 4 per cent of the total production of the United States. At one time (1896), by producing 25,000,000 barrels, the field contributed 41.43 per cent to the total production of the United States, but it has now fallen to 4,773,138 barrels, which is only 1.93 per cent of the total production.

The production of petroleum in the Lima-Indiana oil field from 1886 to 1913, inclusive, is given in the following table:

Production of petroleum in the Lima-Indiana field, 1886–1913, in barrels.

Year.	Production.	Percentage of total production.	Increase (+) or decrease (−) from preceding year.	Percentage of increase (+) or decrease(−)	Value.	Yearly average price per barrel.
1886	1,137,[illegible]69	4.06	.....	.....	$444,198	$0.39
1887	4,650,375	16.44	+3,512,506	+308.69	953,327	.205
1888	9,682,683	35.07	+5,032,308	+108.21	1,452,402	.150
1889	12,186,564	34.66	+2,503,881	+ 25.86	1,833,859	.150
1890	15,078,378	32.91	+2,891,814	+ 23.73	4,536,927	.301
1891	17,452,612	32.15	+2,374,234	+ 15.75	5,333,797	.306
1892	15,867,575	31.41	−1,585,037	− 9.08	5,814,629	.366
1893	15,982,097	33.00	+ 114,522	+ .75	7,497,597	.469
1894	17,296,510	35.05	+1,314,413	+ 8.22	8,306,025	.480
1895	20,236,741	38.26	+2,940,231	+ 17.00	14,184,356	.700
1896	25,255,870	41.43	+5,019,129	+ 24.80	16,678,028	.660
1897	22,805,033	37.71	−2,450,837	− 9.70	10,848,097	.476
1898	20,321,323	36.71	−2,483,710	− 10.89	12,458,904	.613
1899	20,225,356	35.44	− 95,967	− .47	18,082,723	.894
1900	21,758,750	34.20	+1,533,394	+ 7.58	21,367,267	.982
1901	21,933,379	31.61	+ 174,629	+ .80	18,734,438	.854
1902	23,358,026	26.31	+1,425,247	+ 6.50	20,810,694	.890
1903	24,080,664	23.97	+ 721,638	+ 3.09	27,825,466	1.155
1904	24,689,184	21.09	+ 608,920	+ 2.53	26,970,803	1.092
1905	22,294,171	16.55	−2,395,013	− 9.70	19,466,901	.873
1906	17,554,061	13.88	−4,739,510	− 21.26	15,927,707	.907
1907	13,121,094	7.90	−4,433,567	− 25.26	11,962,410	.912
1908	10,032,305	5.62	−3,088,789	− 23.54	10,065,768	1.003
1909	8,211,443	4.48	−1,820,862	− 18.15	7,449,107	.907
1910	7,253,981	3.46	− 957,582	− 11.66	5,750,104	.793
1911	6,231,164	2.83	−1,022,697	− 14.10	5,116,964	.821
1912	[a] 4,925,906	2.21	−1,305,258	− 20.95	4,794,784	.932
1913	4,773,138	1.93	− 152,768	− 3.10	6,588,068	1.380
Total	428,396,932	13.96	.....	.....	311,255,260	.727

[a] Includes production of Michigan.

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Production of petroleum in the Lima-Indiana field in 1912 and 1913, by States, showing decrease and percentage of decrease, in barrels.

District.	Production.			Percentage decrease.
	1912.	1913	Decrease.	
North Lima	[a] 3,237,926	3,144,968	92,958	2.87
South Lima	717,971	672,075	45,896	6.39
Indiana	970,009	956,095	13,914	1.43
Total	4,925,906	4,773,138	152,768	3.10

[a] Includes production of Michigan.

Production, value, and average price per barrel of petroleum in the Lima-Indiana field, 1905–1913, in barrels.

Year.	North Lima, Ohio.		Average price per barrel.	South Lima, Ohio.		Average price per barrel.
	Quantity.	Value.		Quantity.	Value.	
1905	6,931,635	$6,290,459	$0.907	4,398,289	$3,771,533	$0.857
1906	6,859,669	6,479,607	.944	3,021,515	2,678,034	.886
1907	6,399,917	6,016,238	.940	1,593,140	1,409,242	.885
1908	5,430,124	5,574,400	1.027	1,318,552	1,287,485	.977
1909	4,761,065	4,434,277	.931	1,154,292	1,017,220	.881
1910	4,131,060	3,431,618	.831	963,076	750,011	.779
1911	3,676,397	3,221,108	.876	859,478	666,811	.776
1912	[a] 3,237,926	3,237,949	1.000	717,971	670,960	.934
1913	3,144,968	4,403,858	1.400	672,075	904,984	1.346

Year.	Indiana.		Average price per barrel.	Total.		Average price per barrel.
	Quantity.	Value.		Quantity.	Value.	
1905	10,964,247	$9,404,909	$0.858	22,294,171	$19,466,901	$0.873
1906	7,673,477	6,770,066	.882	17,554,661	15,927,707	.907
1907	5,128,037	4,536,930	.885	13,121,094	11,962,410	.912
1908	3,283,629	3,203,883	.976	10,032,305	10,065,768	1.003
1909	2,296,086	1,997,610	.870	8,211,443	7,449,107	.907
1910	2,159,725	1,568,475	.726	7,253,861	5,750,104	.793
1911	1,695,289	1,228,835	.725	6,231,164	5,116,954	.821
1912	970,009	885,975	.913	4,925,906	4,794,784	.932
1913	956,095	1,279,226	1.337	4,773,138	6,588,068	1.380

[a] Includes production of Michigan.

Production of petroleum in the Lima-Indiana field, 1909–1913, by months and years, in barrels.

Month.	1909	1910	1911	1912	1913
January	722,201	573,742	541,714	318,785	409,902
February	652,025	525,559	499,770	308,755	346,167
March	787,910	651,605	768,873	398,094	336,321
April	735,621	606,702	514,381	459,811	427,768
May	731,231	622,447	545,007	481,496	411,245
June	727,377	729,242	525,481	439,984	390,532
July	717,199	635,859	487,953	455,238	401,394
August	686,340	637,249	505,856	444,752	391,953
September	655,177	586,639	479,695	400,677	400,905
October	640,293	569,978	483,435	437,515	424,560
November	628,716	557,431	419,807	383,094	394,534
December	527,353	557,408	459,192	397,705	437,857
Total	8,211,443	7,253,861	6,231,164	4,925,906	4,773,138

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Average daily production of petroleum in the Lima-Indiana field each month, 1909–1913, by months and years, in barrels.

Month.	1909	1910	1911	1912	1913
January	23,297	18,508	17,475	10,283	13,223
February	23,287	18,770	17,849	10,647	12,363
March	25,416	21,020	24,802	12,842	10,849
April	24,521	20,223	17,146	15,327	14,259
May	23,588	20,079	17,581	15,532	13,266
June	24,246	24,308	17,516	14,666	13,017
July	23,135	20,512	15,740	14,685	12,948
August	22,140	20,556	16,318	14,347	12,644
September	21,839	19,555	15,990	13,356	13,364
October	20,655	18,386	15,595	14,113	13,695
November	20,891	18,581	13,994	12,770	13,151
December	17,011	17,981	14,813	12,829	14,124
Average	22,497	19,874	17,072	13,459	13,077

PIPE-LINE RUNS IN LIMA-INDIANA OIL FIELD.

Pipe-line runs in the Lima-Indiana oil field in 1912 and 1913, by months, in barrels.

1912.

Month.	Buckeye pipe line.	Other Ohio.	Indiana pipe line.	Other Indiana.	Total.
January	188,717	65,665	45,355	19,048	318,785
February	182,946	62,818	41,879	21,112	308,755
March	220,845	87,101	59,056	22,092	398,094
April	262,325	104,521	71,417	21,548	459,811
May	276,078	104,316	78,666	22,436	481,496
June	252,928	101,237	66,980	18,839	439,984
July	263,961	101,246	71,335	18,676	455,228
August	257,578	100,682	67,069	19,423	444,752
September	231,015	91,230	62,649	15,783	400,677
October	254,144	99,737	66,222	17,412	437,515
November	220,209	93,152	54,426	15,307	383,094
December	225,146	[a] 99,980	54,868	18,411	397,706
Total	2,844,912	[a] 1,110,985	739,922	230,087	4,925,906

1913.

January	234,428	102,237	56,477	16,760	409,902
February	191,841	83,990	55,024	15,312	346,167
March	191,646	87,471	39,137	18,067	336,321
April	244,764	104,440	59,179	19,385	427,768
May	233,760	100,106	59,636	17,743	411,245
June	220,054	97,422	54,643	18,413	390,532
July	229,084	98,472	55,947	17,891	401,394
August	223,957	95,529	51,136	21,331	391,953
September	225,303	94,140	49,574	31,888	400,905
October	239,187	93,905	49,423	42,145	424,660
November	207,835	88,255	44,873	53,571	394,534
December	232,531	96,786	50,055	58,485	437,857
Total	2,674,390	1,142,653	625,104	330,991	4,773,138

[a] Includes production of Michigan.

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Pipe-line runs and deliveries of Lima-Indiana oil, by months, in barrels, in 1912 and 1913, and stocks at end of each month.

Month.	1912			1913		
	Runs.	Deliveries.	Stocks.	Runs.	Deliveries.	Stocks.
Dec. 31, 1911			3,194,985			
January	318,785	503,806	3,009,964	499,902	374,280	2,455,163
February	308,755	292,617	3,026,102	346,167	442,569	2,358,761
March	396,094	377,539	3,046,657	336,321	439,064	2,256,018
April	459,811	435,192	3,071,276	427,768	330,353	2,353,433
May	481,496	997,635	2,555,137	411,245	694,753	2,169,925
June	439,984	407,254	2,587,867	390,532	480,573	2,079,884
July	455,238	809,024	2,234,081	401,394	325,058	2,156,220
August	444,752	281,357	2,397,476	391,953	481,723	2,067,450
September	400,677	261,603	2,536,550	400,905	317,730	2,150,625
October	437,515	737,646	2,236,419	424,560	673,064	1,902,121
November	383,094	372,827	2,246,686	394,534	428,586	1,768,069
December	[a] 397,705	224,850	2,419,541	437,857	458,571	1,746,355
Total	[a] 4,925,906	5,701,350		4,773,138	5,446,324	

[a] Includes production of Michigan.

PRICES OF PETROLEUM IN LIMA-INDIANA FIELD.

In the following table are given the fluctuations in prices for the various grades of Lima and Indiana oil in 1911–1913. The dates are those on which changes in prices were made.

Fluctuations in prices of Lima (Ohio) and Indiana petroleum in 1911–1913, per barrel.

Date.	1911			Date.	1912			Date.	1913		
	North Lima.	South Lima and Indiana.	Princeton, Ind.		North Lima.	South Lima and Indiana.	Princeton, Ind.		North Lima.	South Lima and Indiana.	Princeton, Ind.
Jan. 1	$0.82	$0.77	$0.60	Jan. 1	$0.84	$0.79	$0.67	Jan. 1	$1.25	$1.20	$1.05
May 2	.82	.77	.63	Jan. 2	.87	.82	.70	Jan. 3			1.08
June 14	.82	.77	.65	Jan. 6	.89	.84	.72	Jan. 6	1.28	1.23	
Sept. 15	.84	.79	.67	Jan. 24	.92	.87		Jan. 27	1.31	1.26	1.11
				Feb. 1	.95	.90	.75	Feb. 1	1.34	1.29	1.14
				Mar. 4	.98	.93	.81	Feb. 5			1.17
				Apr. 24	1.00	.95	.83	Feb. 6	1.37	1.32	1.20
				May 20	1.02	.97		Feb. 20			1.25
				May 24			.85	Apr. 16	1.39	1.34	1.30
				July 25	1.04	.99	.87	Nov. 5	1.44	1.39	1.35
				Oct. 28	1.07	1.02		Nov. 22	1.49	1.44	
				Nov. 9	1.09	1.04	.89	Dec. 9			1.45
				Nov. 15	1.11	1.06	.91				
				Nov. 25	1.13	1.08	.93				
				Dec. 2	1.16	1.11	.96				
				Dec. 9	1.19	1.14	.99				
				Dec. 16	1.22	1.17	1.02				
				Dec. 23	1.25	1.20	1.05				

In the following table are given the average monthly prices of Lima (Ohio) and Indiana petroleum, per barrel of 42 gallons each, in 1911–1913:

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Average monthly prices of Ohio and Indiana petroleum in 1911, 1912, and 1913, per barrel.

Month.	1911			1912			1913		
	North Lima.	South Lima and Indiana.	Princeton, Ind.	North Lima.	South Lima and Indiana.	Princeton, Ind.	North Lima.	South Lima and Indiana.	Princeton, Ind.
January	$0.82	$0.77	$0.60	$0.89	$0.84	$0.72	$1.28	$1.23	$1.06
February	.82	.77	.60	.95	.90	.75	1.36	1.31	1.21
March	.82	.77	.60	.96	.93	.80	1.37	1.32	1.25
April	.82	.77	.60	.96	.93	.81	1.38	1.33	1.28
May	.82	.77	.63	1.01	.96	.83	1.39	1.34	1.30
June	.82	.77	.64	1.02	.97	.85	1.39	1.34	1.30
July	.82	.77	.65	1.02	.97	.85	1.39	1.34	1.30
August	.82	.77	.65	1.04	.99	.87	1.39	1.34	1.30
September	.83	.78	.66	1.04	.99	.87	1.39	1.34	1.30
October	.84	.79	.67	1.04	.99	.87	1.39	1.34	1.30
November	.84	.79	.67	1.10	1.05	.90	1.45	1.41	1.34
December	.84	.79	.67	1.21	1.16	1.01	1.49	1.44	1.42
Average	.826	.776	.637	1.023	.973	.844	1.390	1.340	1.282
Average of North Lima, South Lima, and Indiana	.801			.998			1.375		

In the following table will be found the highest, lowest, and average prices of Lima (Ohio) oil for the last 10 years:

Highest, lowest, and average prices of Lima (Ohio) petroleum, 1904–1913, per barrel.

Year.	Highest.	Lowest.	Average.	Year.	Highest.	Lowest.	Average.
1904	[a] $1.36	[b] $0.95	$1.104	1909	[a] $1.04	[b] $0.79	$0.906
1905	[a] 1.01	[b] .81	.888	1910	[a] .84	[b] .77	.804
1906	[a] .98	[b] .85	.911	1911	[a] .84	[b] .77	.801
1907	[a] .94	[b] .85	.909	1912	[a] 1.25	[b] .79	.998
1908	[a] 1.04	[b] .89	1.001	1913	[a] 1.49	[b] 1.20	1.375

[a] North Lima. [b] South Lima.

WELL RECORD.

The rise in prices so stimulated the drilling in this field that 1,283 wells were completed as compared with just half that number (640) in 1912. The proportion of producing oil wells obtained by this drilling likewise was practically double that of 1912. The average initial production per well also increased from 15.2 to 17.1 barrels per well per day.

Number of wells completed in the Lima-Indiana field, 1909–1913, by districts.

District.	Oil.					Dry.					Total completed.[a]				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Lima, Ohio	787	501	480	482	873	[a] 85	57	32	55	90	872	572	527	551	972
Indiana	219	284	74	65	213	[a] 86	66	35	20	86	305	366	117	89	311
Total	1,006	785	554	547	1,086	[a] 171	123	67	75	176	1,177	938	644	640	1,283

[a] Including gas wells.

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Number of oil wells and dry holes drilled in the Lima-Indiana field in 1913, by districts and months.

District.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Lima, Ohio..	48	4	39	3	57	8	41	10	70	8	73	6	98	6	102	16	83	13	88	8	86	4	88	4	873	90	482	55
Indiana.....	3	2	9	..	13	3	4	..	17	2	16	5	14	7	28	6	18	15	27	15	34	11	30	20	213	86	65	20
Total..	51	6	48	3	70	11	45	10	87	10	89	11	112	13	130	22	101	28	115	23	120	15	118	24	1,086	176	547	75

Number of oil wells drilled in the Lima-Indiana field, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909.....	110	64	83	100	83	112	87	92	79	74	60	62	1,006
1910.....	33	51	52	61	66	84	86	83	76	59	82	52	785
1911.....	50	48	47	43	45	48	45	49	53	45	45	36	554
1912.....	17	20	24	34	47	48	50	54	62	52	70	69	547
1913.....	51	48	70	45	87	89	112	130	101	115	120	118	1,086

Number of dry holes drilled in the Lima-Indiana field, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909.....	18	11	13	10	13	16	12	13	11	19	19	16	[a] 171
1910.....	8	6	7	9	10	8	11	11	12	9	21	11	[b] 123
1911.....	7	7	2	3	6	7	9	7	2	4	11	2	[b] 67
1912.....	3	2	5	8	5	5	8	9	13	7	7	3	[b] 75
1913.....	6	3	11	10	10	11	13	22	28	23	15	24	[b] 176

[a] Including gas wells. [b] Not including gas wells.

Total number of wells completed in the Lima-Indiana field, 1909–1913, by months. [a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909.....	128	75	96	110	96	128	99	105	90	93	79	78	1,177
1910.....	47	60	60	73	80	95	97	97	89	70	105	65	938
1911.....	59	58	50	48	52	58	53	57	58	50	62	39	644
1912.....	23	25	31	42	54	54	58	63	77	60	79	74	640
1913.....	58	52	82	57	97	102	129	156	129	140	137	144	1,283

[a] Including gas wells.

Initial daily production of new wells completed in the Lima-Indiana field in 1913, by districts and months, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total, 1913	Total, 1912
Lima, Ohio.	709	439	599	632	871	1,206	1,243	1,414	898	923	1,222	1,025	11,181	7,229
Indiana.....	65	271	327	223	555	467	384	437	756	1,466	1,430	1,012	7,393	1,083
Total..	774	710	926	855	1,426	1,673	1,627	1,851	1,654	2,389	2,652	2,037	18,574	8,312

Total and average initial daily production of new wells in the Lima-Indiana field, 1909–1913, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Lima, Ohio.....	8,118	6,745	6,381	7,229	11,181	10.3	13.5	13.3	15.0	12.8
Indiana.....	3,863	8,664	1,096	1,083	7,393	17.6	30.5	14.8	16.7	34.7
Total.....	11,981	15,409	7,477	8,312	18,574	11.9	19.6	13.5	15.2	17.1

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Total initial daily production of new wells in the Lima-Indiana field, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909.....	1,375	826	767	919	761	1,198	1,073	1,140	1,007	1,163	627	1,125	11,981	998
1910.....	845	1,310	1,320	1,244	1,311	2,192	1,360	1,894	1,194	921	1,013	785	15,409	1,284
1911.....	650	652	452	556	526	636	605	735	545	878	517	675	7,477	623
1912.....	267	281	1,013	490	704	824	690	863	891	635	1,026	628	8,312	693
1913.....	774	710	926	855	1,426	1,673	1,627	1,851	1,654	2,389	2,652	2,037	18,574	1,548

In the following tables are given the number of oil wells abandoned in the Lima-Indiana oil field from June, 1906, to December 31, 1913, inclusive:

Number of oil wells abandoned in Indiana and in the Lima (Ohio) oil field from June, 1906, to December, 1913, by months.

Month.	1906	1907	1908	1909	1910	1911	1912	1913	Total.
January.....	54	45	75	149	61	62	59	17	522
February.....	74	83	59	108	66	21	34	21	466
March.....	27	49	129	237	221	114	28	13	818
April.....	47	129	198	98	140	31	86	47	776
May.....	100	194	358	204	157	233	83	37	1,366
June.....	82	143	207	347	146	118	122	101	1,294
July.....	50	111	191	157	176	141	75	17	971
August.....	147	170	228	322	126	122	102	71	1,342
September.....	87	157	195	267	294	79	117	127	1,342
October.....	139	181	144	201	80	137	66	142	1,248
November.....	139	177	155	172	100	160	158	38	1,152
December.....	117	62	220	156	128	41	80	40	910
Total, Indiana.....	1,063	1,501	2,159	2,418	1,695	1,259	1,010	671	12,207
Total, Lima, Ohio ...	1,059	1,357	1,135	1,127	1,500	1,142	856	601	9,451
Total, Lima-Indiana...	2,122	2,858	3,294	3,545	3,195	2,401	1,866	1,272	21,658

Number of oil wells abandoned in the Lima-Indiana oil field, June, 1905, to December 31, 1913, by counties.

Lima, Ohio.		Indiana.	
County.	Number of wells.	County.	Number of wells.
Allen.....	2,012	Adams.....	699
Auglaize.....	820	Blackford.....	1,290
Darke.....	4	Delaware.....	1,259
Hancock.....	1,243	Gibson.....	1
Lucas.....	377	Grant.....	3,785
Mercer.....	319	Hamilton.....	9
Ottawa.....	124	Huntington.....	771
Putnam.....	20	Jay.....	510
Sandusky.....	742	Knox.....	12
Seneca.....	117	Madison.....	87
Shelby.....	8	Marion.....	15
Van Wert.....	570	Miami.....	49
Wood.....	2,876	Randolph.....	206
Wyandot.....	219	Wabash.....	16
		Wells.....	3,498
Total.....	9,451	Total.....	12,207

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INDIANA.

DEVELOPMENT.

The Indiana portion of the Lima-Indiana field fared somewhat better than the Ohio portion, inasmuch as the decline was only 1.43 per cent, while the value of the product increased 44.39 per cent, as shown in the following tables.

This checking of the usual rate of decline was effected chiefly by the development of the Sullivan County pool on the western border of the State. The finding of this new pool stimulated drilling so that 311 wells were drilled in the State, of which 132 were in Sullivan County. The average initial production for the new wells drilled in the State was 34.8 barrels, as compared with 16.7 in 1912.

PRODUCTION.

Production of petroleum in Indiana, 1909–1913, by months, in barrels.

Month.	1909	1910	1911	1912	1913
January	202,055	143,481	146,582	64,403	73,237
February	182,914	136,388	135,064	62,991	70,336
March	221,455	163,588	355,552	81,148	57,204
April	211,265	161,965	133,947	92,965	78,764
May	212,575	178,582	139,302	101,102	77,379
June	211,961	292,521	132,096	85,819	73,056
July	205,182	219,210	120,737	90,011	73,838
August	196,306	200,681	122,416	86,492	72,467
September	184,207	179,536	114,109	78,432	81,462
October	172,505	169,338	107,317	83,634	91,368
November	170,871	159,878	89,007	69,733	98,444
December	122,770	154,657	99,160	73,279	108,540
Total	2,296,086	2,159,725	1,695,289	970,009	956,095

WELL RECORD.

In the following tables are given the well record for Indiana from 1909 to 1913, inclusive:

Number of wells completed in Indiana, 1909–1913, by counties.

County.	Oil.					Dry.					Total completed.[a]				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Adams	11	12	1	6	8	3	1	1	.....	.....	14	13	2	6	8
Blackford	19	5	2	2	9	4	2	.....	2	2	23	7	2	4	11
Cass	1	.....	.....	.....	.....	2	.....	.....	.....	.....	3	.....	.....	.....	.....
Daviess	1	1	.....	1	1	.....	.....	2	.....	.....	1	1	7	2	1
Delaware	8	9	10	15	47	5	.....	5	7	8	13	10	15	22	55
Dubois	.....	1	.....	.....	.....	.....	4	.....	.....	.....	.....	5	.....	.....	.....
Gibson	2	2	.....	.....	18	6	7	1	.....	1	8	9	1	.....	19
Grant	35	1	.....	1	1	2	1	.....	1	1	37	2	.....	2	4
Huntington	12	3	.....	.....	.....	3	.....	.....	.....	.....	15	3	.....	.....	.....
Jay	46	21	9	14	27	17	10	3	4	6	63	34	13	20	33
Knox	.....	1	1	1	.....	.....	3	6	4	1	.....	4	7	5	2
Madison	1	.....	.....	.....	.....	.....	.....	3	.....	.....	1	.....	3	.....	.....
Martin	.....	1	.....	.....	.....	.....	1	.....	.....	.....	.....	2	.....	.....	.....
Miami	.....	.....	.....	.....	.....	1	.....	.....	.....	1	1	.....	.....	.....	1
Pike	38	179	27	5	11	27	25	11	1	5	65	215	40	6	20
Pulaski	1	.....	.....	.....	.....	3	.....	.....	.....	.....	4	.....	.....	.....	.....
Randolph	4	13	4	4	8	1	7	.....	.....	3	5	20	4	4	11
Sullivan	.....	3	.....	2	75	.....	.....	.....	.....	52	.....	3	.....	2	132
Vigo	1	.....	.....	1	.....	1	1	.....	.....	.....	2	1	.....	1	.....
Warrick	.....	.....	.....	.....	.....	.....	3	1	.....	.....	.....	3	1	.....	.....
Wells	39	32	17	6	5	.....	.....	.....	.....	1	39	33	17	6	6
Miscellaneous	.....	.....	3	7	3	11	1	2	1	5	11	1	5	9	8
Total	219	284	74	65	213	[a] 86	[b] 66	[b] 35	[b] 20	[b] 86	306	366	117	89	311

[a] Including gas wells. [b] Not including gas wells.

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Number of oil wells and dry holes drilled in Indiana in 1913, by counties and months.

County.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Adams									2		1		1				2		1				1		8		6	
Blackford			1				1				1		1	1	1	1	1		2				1		9	2	2	2
Daviess			1																						1		1	
Delaware		1	6		5		1		9	1	8	2	7	1	2	1	4	2	3		2				47	8	15	7
Gibson	1		1		8	1					1		1		4						1		1		18	1		
Grant																				1			1		1	1	1	1
Jay	1				2	1			2		3	1	2		7		4	1	3	1	1	1	3		27	6	14	4
Knox																					1					1	1	4
Miami																				1						1		
Pike		1							2					2	2		2	1			4	1	1		11	5	5	1
Randolph									1				2	1	2		1	2	1		1				8	3	4	
Sullivan															8	4	4	8	17	12	24	8	22	20	75	52	2	
Vigo																											1	
Wells							1				2	1			1						1				5	1	6	
Miscellaneous	1								1	1		1		2	1			1							3	5	7	1
Total	3	2	9		13	3	4		17	2	16	5	14	7	28	6	18	15	27	15	34	11	30	20	213	86	65	20

Number of oil wells drilled in Indiana, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	21	9	16	20	19	27	19	21	13	16	11	27	219
1910	9	27	26	21	20	34	34	32	28	21	19	13	284
1911	10	6	9	5	6	7	6	7	5	4	3	6	74
1912	2	3	2	3	4	4	7	8	8	9	8	7	65
1913	3	9	13	4	17	16	14	28	18	27	34	30	213

Number of dry holes drilled in Indiana, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	9	7	2	4	7	9	8	6	6	13	5	10	[a] 86
1910	3	4	3	5	4	2	4	6	7	5	16	7	[b] 66
1911	4	3	1	3	2	2	5	4	2	2	7	.....	[b] 35
1912	2	1	1	5	.....	.....	3	2	3	2	.....	1	[b] 20
1913	2	.....	3	.....	2	5	7	6	15	15	11	20	[b] 86

[a] Including gas wells. [b] Not including gas wells.

Total number of wells completed in Indiana, 1909–1913, by months. [a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	30	16	18	24	26	36	27	27	19	29	16	37	305
1910	18	33	29	27	25	38	38	41	35	26	36	20	366
1911	14	10	10	8	8	10	11	11	8	6	15	6	117
1912	5	5	3	8	4	5	10	10	11	12	8	8	89
1913	5	9	17	5	19	22	22	37	33	44	47	51	311

[a] Including gas wells.

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Initial daily production of new wells completed in Indiana in 1913, by counties and months, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total, 1913	Total, 1912
Adams	.....	.....	.....	.....	15	10	10	.....	23	10	.....	5	73	103
Blackford	.....	1	.....	8	.....	5	4	5	2	6	.....	15	46	7
Daviess	.....	10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10	10
Delaware	.....	245	100	150	345	390	230	35	160	55	55	.....	1,765	425
Gibson	15	15	227	.....	.....	15	10	42	.....	.....	5	3	332	.....
Grant	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	5	5
Jay	20	.....	.....	50	28	32	10	88	80	70	15	30	423	204
Knox	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
Pike	.....	.....	.....	.....	42	.....	.....	29	16	.....	65	50	202	150
Randolph	.....	.....	.....	.....	100	.....	120	15	50	100	10	.....	395	35
Sullivan	.....	.....	.....	.....	.....	.....	.....	208	425	1,225	1,270	904	4,032	15
Vigo	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	30
Wells	.....	.....	.....	15	.....	15	.....	10	.....	.....	10	.....	50	31
Miscellaneous	30	.....	.....	.....	25	.....	.....	5	.....	.....	.....	.....	60	65
Total	65	271	327	223	555	467	384	437	756	1,466	1,430	1,012	7,393	1,083

Total and average initial daily production of new wells in Indiana, 1909–1913, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Adams	58	73	10	103	73	5.3	6.1	10.0	17.2	9.1
Blackford	140	75	5	7	46	7.4	15.0	2.5	3.5	5.1
Cass	2	.....	.....	.....	.....	2.0	.....	.....	.....	.....
Daviess	20	5	.....	10	10	20.0	5.0	.....	10.0	10.0
Delaware	142	232	325	425	1,765	17.8	25.8	32.5	28.3	37.6
Dubois	.....	15	.....	.....	.....	.....	15.0	.....	.....	.....
Gibson	35	20	.....	.....	332	17.5	10.0	.....	.....	18.4
Grant	167	1	.....	5	5	4.8	1.0	.....	5.0	5.0
Huntington	77	40	.....	.....	.....	6.4	13.3	.....	.....	.....
Jay	378	203	90	204	423	8.2	9.7	10.0	14.6	15.7
Knox	.....	10	5	3	.....	.....	10.0	5.0	3.0	.....
Madison	40	.....	.....	.....	.....	40.0	.....	.....	.....	.....
Martin	.....	5	.....	.....	.....	.....	5.0	.....	.....	.....
Pike	2,385	7,453	439	150	202	62.7	41.6	16.3	30.0	18.4
Pulaski	5	.....	.....	.....	.....	5.0	.....	.....	.....	.....
Randolph	130	207	26	35	395	32.5	15.9	6.5	8.8	49.4
Sullivan	.....	25	.....	15	4,032	.....	8.3	.....	7.5	53.8
Vigo	20	.....	.....	30	.....	20.0	.....	.....	30.0	.....
Wells	264	300	181	31	50	6.8	9.4	10.6	5.2	10.0
Miscellaneous	.....	.....	15	65	60	.....	.....	5.0	9.3	20.0
Total	3,863	8,664	1,096	1,083	7,393	17.6	30.5	14.8	16.7	34.8

Total initial daily production of new wells in Indiana, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909	308	59	200	241	281	298	467	287	381	445	114	782	3,863	322
1910	488	885	820	714	746	1,745	676	1,159	400	480	290	261	8,664	722
1911	142	53	129	73	66	77	107	155	75	85	52	82	1,096	91
1912	75	60	30	50	85	57	47	82	148	172	187	90	1,083	90
1913	65	271	327	223	555	467	384	437	756	1,466	1,430	1,012	7,393	616

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ILLINOIS OIL FIELD.

GENERAL CONDITIONS.

This State showed the sharpest decline among the large fields. In 1912 the total output was 28,601,308 barrels—already a sharp decline from 33,143,362 barrels in 1910. In 1913 the total fell to 23,893,899 barrels, a decline of 16.45 per cent from 1912. Meanwhile the price per barrel increased 52 per cent, from $0.851 in 1912 to $1.296 in 1913, raising the total value from $24,332,605 in 1912 to $30,971,910 in 1913, a gain of 27.29 per cent.

The decline does not presage exhaustion of the Illinois field, but rather what may be considered settled production for a long time, unless the production should be increased again by the discovery of new oil pools. This is by no means unlikely in view of the great extent of territory which is good prospecting ground and which the energetic Illinois Geological Survey will be encouraged to examine thoroughly during the next few years; for the beneficial work of this organization in past years is well recognized by the oil fraternity.

The only regions that caused any drilling excitement in 1913 were localities in Lawrence County and the town-lot boom in Robinson, Crawford County.

The following description of the development of petroleum in Illinois in the last two years is taken from the advance Circular No. 8 published by the Illinois State Geological Survey.

The sharp decline in State production, beginning in 1912, seems to correspond with the decrease in new development in the deep Lawrence County pools. The sands of this locality have a good staying quality and are expected to yield abundantly for many years. The present rapid drop in their production is normal; later, the decline should continue at a much lower rate. The opening of new fields would probably reverse the situation.

The drain on stored oil in 1912 and 1913 kept pace with the decline in production. The surplus oil in Illinois fields began to accumulate in 1906 and reached the maximum amount about September 1, 1910, with stocks aggregating 29,289,164 barrels. The decline in stocks, until August 1, 1912, averaged about 19,500 barrels per day. From August, 1912, until February, 1913, the daily decline averaged about 23,400 barrels, and since that time about 16,000 barrels a day.

A general advance in prices of Illinois oil has accompanied the decline in production and stocks. This has been due chiefly to the demand for motor fuels and to other prevailing economic conditions. The present price of $1.45 per barrel as against 67 cents, January 1, 1912, is a large inducement to extensive wildcat work in the effort to locate new fields. From January 1, 1908, to December 20, 1912, Illinois oil was graded and sold according to difference in specific gravity. Since then the grading has been abolished, and now all of the oil of the State commands one price.

SOUTHEASTERN ILLINOIS.

Shallow fields.—The Clark, Cumberland, Coles, and Edgar County fields (shallow oil-sand territory) showed a very low but steady yield of oil in 1912 and 1913. These pools produce from 1 to 3 barrels of oil per day per well and seem to be profitable in 1914 where a number of wells are pumped on one central power. Until very recently there has been but little active drilling. Several wells were drilled in the area in 1912 to a depth of about 2,500 feet, in which small quantities of high-grade sour oil were found. The producing zone is thought to correspond to the Trenton limestone. The expense of drilling with such small returns is almost prohibitive of extensive

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development to this horizon; but the presence of oil has induced some recent investigation of the Trenton northward along the La Salle anticline between Pesotum and Mahomet, where the depth is much less. Very recently a new shallow sand was discovered in Clark County, beneath the old productive sand, and is attracting considerable attention. The production from this pay is not as great as in the old sand, but its shallow depth makes it a profitable venture. The combined daily output of the shallow fields in 1913 was about 5,000 barrels as against 9,000 in 1910.

Crawford County.—Like the shallow fields, the Crawford County area, with its 900-foot sands, was rapidly developed and drained, and is now maintaining a low but steady yield. The average daily output in 1913 was about 15,000 barrels, as against 30,000 barrels in 1910 and 100,000 barrels in 1907. The two chief additions to the field in the last three years were the development of the New Hebron pool, and the deep sand, at 1,350 feet, north of Oblong. In 1912 and 1913, the drilling was for the most part confined to inside field locations which did not add materially to the general output. At the close of 1913 oil was found on a town lot in the north part of Robinson in Crawford County. Considerable excitement ensued, and now about 15 wells are drilling.

Lawrence County.—Lawrence County is the richest oil-producing area in the State. There are seven sands from 450 to 1,985 feet in depth that produce large quantities of high-grade oil. In order of depth they are: The Shallow sand, 450 feet (very limited in areal extent); the Bridgeport sand of three lenses, 750 to 1,000 feet; the Buchanan sand, 1,250 to 1,380 feet; the "Gas" sand, 1,200 to 1,300 feet; the Kirkwood sand, 1,320 to 1,985 feet (variableness of depth due to structure); the Tracy sand, 1,500 to 1,750 feet; and the McClosky limestone, 1,600 to 1,850 feet. These sands rank in production as follows: McClosky, Kirkwood, Buchanan, Bridgeport, Tracy, "Gas," and Shallow. The accumulation of oil in all of the sands is governed by a strong double-plunging anticline. Until late in 1912, the remarkably steady production of the Lawrence County sands did much to retard the decline of general production. Since this time, the initial high yield has given way to a rapid decline that has affected the State yield. In 1912, the drilling in the county was confined mostly inside of the oil fields and consisted of wells which tap the McClosky sand. Many of the new wells were reported with initial productions from 500 to 2,400 barrels a day and a large number of the oil wells drilled to shallower sands were deepened to the McClosky. Several isolated oil pools were opened in 1912 and 1913, near Lawrenceville. The largest lies just northwest of this place and produces from the Buchanan sand. Three smaller pools in the Kirkwood sand lie southeast of the town in sec. 8, 15, and 17, T. 3 N., R. 11 W. General drilling in the county was greatly handicapped in 1913, because of an extensive summer drought and a consequent shortage of water. The average daily output for the county was about 35,000 barrels as against 45,000 in 1912.

Wabash County.—A small pool of oil of about 37° Baumé gravity was discovered and defined in 1912, in secs. 3, 4, 9, and 10, T. 1 N., R. 12 W. It was named after the nearby town of Allendale. This pool was disappointing in areal extent. There are at present 36 pro-

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ducing wells with a daily production of about 700 barrels. The oil comes from a depth of about 1,480 to 1,550 feet in a sand which seems to correspond to the Kirkwood sand of Lawrence County. The governing structure of the pool has the appearance of an isolated shelf along the steep western limb of the La Salle anticline.

SOUTH-CENTRAL AND WESTERN ILLINOIS.

Clinton County.—The Carlyle pool, 3 miles northwest of Carlyle, has shown a steady decline in the last two years. There are at present 154 wells and a combined daily production of about 1,070 barrels as against 120 wells and 4,500 barrels at the close of 1911. Only 14 new wells were added to the field during 1913. Their combined initial yield was 134 barrels.

Marion County.—The Sandoval pool, just north of Sandoval, has 112 producing wells and a combined daily yield of about 875 barrels, as against 66 wells and 1,800 barrels in 1911. There were 23 new wells added to the field in 1913, with an initial production of 492 barrels. Both the Sandoval and the Carlyle pools have been profitable because of their continued yield. A small oil well of about 20 barrels initial yield was discovered a mile south of the old Brown well east of Centralia. The producing sand corresponds to the Benoist sand in the Sandoval pool.

Macoupin County.—The Carlinville pool, two miles south of Carlinville, now has six gas wells and eight oil wells. One of the oil wells is credited with an initial yield of 100 barrels of thick heavy oil, which characterized the field. The daily yield of the field is about 200 barrels. The oil comes from the Pottsville sandstone formation overlying the St. Louis limestone or "Big lime."

MISCELLANEOUS DRILLING.

In 1912, barren wells were drilled near Murphysboro, Ava, Grubbs, Denny, Nashville, O'Fallon, Virden, Watson, Camargo, Keensburg, Jacksonville, Edwardsville, and Villa Grove. In 1913, dry holes were drilled near Equality, Harrisburg, Duquoin, Murphysboro, Hoffman, Hoyleton, Edwardsville, Millstadt, Pinkstaff, Kinsman, Lexington, Dundas, Anna, Olive Branch, and Villa Grove. New drilling is going on or is contemplated near Allerton, Vandalia, Pesotum, Sadorus, Mahomet, Sorento, Birmingham, and Hillsboro.

The discovery of the Allendale pool and its rapid development in June and July, 1912, caused the average initial production to exceed that of any month in the last two years. The confinement of drilling to proved territory that had already suffered considerably drain is well shown by the difference in the total well completions, new production, and the average initial yield per producing well.

On January 1, 1913, it was estimated that 21,238 wells had been drilled in Illinois. Of these, 3,422, or 16.1 per cent, were barren. In 1913, 1,749 wells were drilled, of which 310, or 17.7 per cent, were barren. The total number up to January 1, 1914, is 22,987 wells drilled, of which 3,732, or 16.2 per cent, are dry.

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PRODUCTION.

The production of petroleum in the Illinois field from 1889 to 1913, inclusive, is given in the following table:

Production of petroleum in Illinois, 1889–1913, in barrels.

Year.	Production.	Percentage of total production.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).	Value.	Yearly average price per barrel.
1889	1,460				$4,906	$3.360
1890	900		− 560	− 38.36	3,000	3.333
1891	675		− 225	− 25.00	2,363	3.500
1892	521		− 154	− 22.81	1,823	3.500
1893	400		− 121	− 23.22	1,400	3.500
1894	300		− 100	− 25.00	1,800	6.000
1895	200		− 100	− 33.33	1,200	6.000
1896	250		+ 50	+ 25.00	1,250	5.000
1897	500		+ 250	+ 100.00	2,000	4.000
1898	360		− 140	− 28.00	1,800	5.000
1899	360				1,800	5.000
1900	200		− 160	− 44.44	1,000	5.000
1901	250		+ 50	+ 25.00	1,250	5.000
1902	200		− 50	− 20.00	1,000	5.000
1903			− 200	− 100.00		
1904						
1905	181,084	0.13	+ 181,084		116,561	.644
1906	4,397,050	3.47	+ 4,215,966	+2,328.18	3,274,818	.745
1907	24,281,973	14.62	+19,884,923	+ 452.23	16,432,947	.677
1908	33,686,238	18.87	+ 9,404,265	+ 38.73	22,649,561	.672
1909	30,898,339	16.87	− 2,787,899	− 8.28	19,788,864	.640
1910	33,143,362	15.82	+ 2,244,923	+ 7.27	19,669,383	.593
1911	31,317,038	14.21	− 1,826,224	− 5.51	19,734,339	.630
1912	28,601,308	12.83	− 2,715,730	− 8.67	24,332,605	.851
1913	23,893,899	9.62	− 4,707,409	− 16.45	30,971,910	1.296
Total	210,406,867	6.85			156,997,580	.746

Production of petroleum in Illinois, 1909–1913, by months, in barrels.

Month.	1909	1910	1911	1912	1913
January	2,668,607	2,640,303	2,578,579	2,241,867	2,149,264
February	2,510,548	2,353,684	2,373,229	2,262,440	1,859,412
March	2,757,794	2,865,055	2,790,515	2,369,428	2,008,245
April	2,562,215	2,776,800	2,580,963	2,351,693	2,015,058
May	2,829,277	2,860,760	2,731,965	2,535,039	2,117,425
June	2,670,549	2,746,620	2,634,521	2,503,038	2,003,278
July	2,728,857	3,029,787	2,740,654	2,698,582	2,075,444
August	2,719,958	3,007,151	2,770,946	2,519,651	2,001,228
September	1,902,197	2,850,119	2,615,120	2,366,712	1,942,052
October	2,560,072	2,768,750	2,638,927	2,424,472	1,982,002
November	2,497,847	2,629,132	2,400,670	2,174,856	1,819,116
December	2,490,418	2,615,301	2,480,949	2,153,530	1,921,375
Total	30,898,339	33,143,362	31,317,038	28,601,308	23,893,899

Average daily production of petroleum in Illinois each month, 1909–1913, by months and years, in barrels.

Month.	1909	1910	1911	1912	1913
January	86,084	85,171	83,180	72,318	69,331
February	89,662	84,060	84,758	78,015	66,407
March	88,961	92,421	90,017	76,433	64,782
April	85,407	92,560	85,365	78,390	67,169
May	91,267	92,283	88,128	81,775	68,304
June	89,018	91,554	87,817	83,435	66,776
July	88,028	97,735	88,408	87,051	66,950
August	87,741	97,005	89,385	81,279	64,556
September	63,407	95,004	87,171	78,890	64,735
October	82,583	89,315	85,127	78,209	63,936
November	83,262	87,638	80,022	72,495	60,637
December	80,336	84,361	80,031	69,469	61,980
Average	84,653	90,804	85,800	78,146	65,463

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Production and value of petroleum in Illinois, 1906–1913, in barrels.

Year.	Ohio Oil Co.	Other lines.	Total quantity.	Total value.
1906	4,385,471	11,579	4,397,050	$3,274,818
1907	23,733,790	548,183	24,281,973	16,432,947
1908	31,972,634	1,713,004	33,686,238	22,649,561
1909	27,640,773	3,257,566	30,898,339	19,788,864
1910	27,751,090	5,392,272	33,143,362	19,669,383
1911	25,987,480	5,329,558	31,317,038	19,734,339
1912	23,137,234	5,464,074	28,601,308	24,332,605
1913	17,585,155	6,308,744	23,893,899	30,971,910

PIPE-LINE RUNS, DELIVERIES, AND STOCKS.

Pipe-line runs and deliveries to trade of petroleum from Illinois, by months, in 1913, and stocks at end of each month, in barrels.

Month.	Runs.	Deliveries.	Stocks.[a]
Dec. 31, 1912			15,709,738
January	2,149,264	3,075,502	14,783,500
February	1,859,412	2,722,247	13,920,665
March	2,008,245	2,533,839	13,395,071
April	2,015,068	2,659,425	12,750,704
May	2,117,425	2,622,819	12,245,310
June	2,003,278	2,533,606	11,714,982
July	2,075,444	2,706,745	11,083,681
August	2,001,228	2,413,448	10,671,461
September	1,942,062	2,814,292	9,799,221
October	1,982,002	2,623,700	9,157,523
November	1,819,116	2,329,011	8,647,628
December	1,921,375	2,325,582	8,243,421
Total	23,893,899	31,360,216	

[a] Includes a small quantity of Indiana oil of Illinois grade.

The following tables show the runs, deliveries, and stocks of the Ohio Oil Co. during the years 1909–1913, by months:

Pipe-line runs, deliveries, and stocks of the Ohio Oil Co. in Illinois, 1909–1913, by months, in barrels.

PIPE-LINE RUNS.

Month.	1909	1910	1911	1912	1913
January	2,494,492	2,220,842	2,137,074	1,853,266	1,691,944
February	2,358,198	1,976,837	1,968,429	1,853,379	1,348,292
March	2,568,302	2,377,012	2,349,308	1,949,945	1,457,711
April	2,388,309	2,306,336	2,138,500	1,916,071	1,456,551
May	2,536,413	2,374,134	2,264,925	2,084,743	1,551,323
June	2,365,956	2,274,501	2,177,380	2,083,087	1,471,437
July	2,413,218	2,569,330	2,265,374	2,230,164	1,531,800
August	2,411,483	2,528,532	2,312,073	1,996,324	1,483,801
September	1,595,934	2,409,232	2,154,493	1,871,325	1,437,974
October	2,228,269	2,334,659	2,172,457	1,901,119	1,473,679
November	2,149,372	2,211,286	1,977,073	1,668,306	1,360,159
December	2,130,737	2,168,069	2,068,494	1,594,700	1,420,484
Total	27,640,773	27,751,090	25,987,480	23,002,929	17,585,155

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Pipe-line runs, deliveries, and stocks of the Ohio Oil Co. in Illinois, 1909–1913, by months, in barrels—Continued.

DELIVERIES.[a]

Month.	1909	1910	1911	1912	1913
January	324,887	1,226,379	933,861	1,350,621	1,201,633
February	869,212	842,135	838,566	1,387,078	1,042,834
March	721,519	882,209	1,218,111	1,532,428	1,172,522
April	891,423	936,706	1,022,936	1,420,013	1,139,433
May	903,838	946,346	1,132,231	1,301,727	1,226,625
June	1,077,383	1,156,895	1,174,211	1,302,537	1,161,667
July	1,176,410	1,332,242	1,231,534	1,327,329	1,171,492
August	1,052,431	1,229,479	1,206,244	1,306,563	794,844
September	849,533	1,135,323	1,252,988	1,359,968	1,039,267
October	938,860	1,245,778	1,352,605	1,401,807	1,065,320
November	1,120,751	997,805	1,304,663	1,230,357	810,907
December	685,585	1,036,260	1,454,394	1,206,516	1,204,375
Total	10,611,832	12,967,557	14,122,344	16,126,944	13,030,919

STOCKS.[b]

January	25,876,529	28,355,182	26,252,274	18,393,303	11,118,521
February	26,203,238	28,356,343	25,643,012	17,706,835	10,344,393
March	26,630,509	28,373,355	24,005,215	17,279,112	9,935,612
April	26,856,675	28,593,365	24,013,861	17,001,576	9,446,550
May	27,593,494	29,025,647	24,138,187	16,636,329	8,941,584
June	27,899,220	29,106,098	23,195,749	16,235,353	8,054,011
July	27,627,086	29,198,965	22,714,129	15,689,994	7,548,743
August	27,683,334	29,177,382	22,265,928	14,682,823	6,876,978
September	28,399,427	28,879,076	21,904,719	13,949,064	6,416,698
October	28,535,636	28,492,136	21,359,482	13,039,507	5,748,180
November	28,373,985	28,086,619	20,211,934	12,307,725	5,829,018
December	28,671,543	27,348,358	19,131,678	11,591,427	5,551,556

[a] These deliveries are to trade only. Deliveries to other pipe lines are also made.
[b] Stocks 1910, 1911, 1912, and 1913 include some Indiana petroleum of Illinois grade.

RAILROAD SHIPMENTS.

The following table shows the quantity of petroleum shipped by railroad from the Illinois oil field, 1907–1913, by months. The shipments were made by the Vandalia Railroad Co., the Baltimore & Ohio Southwestern Railroad Co., the Illinois Southern Railway Co., the Indianapolis Southern Railroad Co., and the Cleveland, Cincinnati, Chicago & St. Louis Railway from Lawrenceville, Flat Rock, Sparta, Stoy, Bridgeport, Robinson, Sandoval, and Casey stations.

Shipments of petroleum by railroad in tank cars from Illinois oil field, in barrels, 1907–1913, by months.

Month.	1907 [a]	1908 [a]	1909 [a]	1910 [a]	1911 [a]	1912 [a]	1913 [a]
January	8,701	91,807	144,511	220,856	228,404	232,522	192,735
February	14,598	71,170	111,407	217,917	224,856	172,106	167,632
March	23,947	132,300	152,056	263,056	254,927	216,156	176,028
April	42,249	118,074	109,872	257,292	347,530	211,809	135,341
May	158,227	84,290	157,783	283,285	333,324	232,043	226,364
June	166,644	122,317	183,432	285,095	329,621	214,860	224,614
July	322,622	107,688	158,642	276,533	311,681	211,025	272,536
August	223,134	70,171	166,943	277,317	297,784	281,991	264,424
September	70,555	83,042	173,509	253,788	238,917	210,974	271,709
October	56,570	102,163	200,067	213,217	292,004	249,263	299,451
November	56,080	138,147	198,044	287,750	263,627	222,866	291,287
December	66,692	126,967	185,166	234,819	285,082	219,034	298,227
Total	1,210,019	1,248,136	1,941,432	3,070,925	3,407,757	2,674,649	2,820,348

[a] Calculations made according to the specific gravity of the oil, ranging from 296.476 to 321.17 pounds to the barrel.

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PRICES.

In the following table are given the dates of change and the changes in prices at wells of the different grades of petroleum produced in Illinois during the years 1911–1913:

Fluctuation in prices, per barrel, of Illinois petroleum in 1911–1913.

Date.	Above 30° B.	Below 30° B.	Date.	Above 30° B.	Below 30° B.	Date.	Above 30° B.	Below 30° B.
1911.			1912—Con.			1913.		
Jan. 1	$0.60	$0.52	May 24	$0.85	$0.75	Jan. 1	$1.08	$1.05
May 2	.63	.55	June 13	.....	.77	Jan. 3	1.08	.....
June 14	.65	.55	June 27	.....	.79	Jan. 27	1.11	.....
Sept. 15	.67	.55	July 25	.87	.82	Feb. 2	1.14	.....
Sept. 19	.67	.57	Sept. 12	.....	.84	Feb. 5	1.17	.....
			Oct. 28	.90	.87	Feb. 6	1.20	.....
1912.			Nov. 9	.92	.89	Feb. 20	1.25	.....
Jan. 1	.67	.57	Nov. 15	.94	.91	Apr. 16	1.30	.....
Jan. 2	.70	.60	Nov. 25	.96	.93	Nov. 5	1.35	.....
Jan. 6	.72	.62	Dec. 2	.99	.96	Nov. 19	1.40	.....
Jan. 24	.75	.65	Dec. 9	1.02	.99	Nov. 22	1.45	.....
Feb. 1	.78	.68	Dec. 16	1.05	1.02			
Mar. 4	.81	.71	Dec. 20	.....	1.05			
Apr. 24	.83	.73	Dec. 23	1.08	1.05			

In the following table are given the average monthly prices paid for Illinois petroleum at wells in Illinois from 1909 to 1913, inclusive:

Average monthly prices of Illinois petroleum, 1909–1913, per barrel.

Month.	1909		1910		1911		1912		1913
	Above 30° B.	Below 30° B.	Above 30° B.	Below 30° B.	Above 30° B.	Below 30° B.	Above 30° B.	Below 30° B.	
January	$0.68	$0.60	$0.60	$0.52	$0.60	$0.52	$0.72	$0.62	$1.09
February	.68	.60	.60	.52	.60	.52	.78	.68	1.21
March	.68	.60	.60	.52	.60	.52	.81	.71	1.25
April	.68	.60	.60	.52	.60	.52	.81	.71	1.28
May	.68	.60	.60	.52	.63	.55	.84	.74	1.30
June	.67½	.59½	.60	.52	.64	.55	.85	.76	1.30
July	.62⅝	.55⅝	.60	.52	.65	.55	.85	.80	1.30
August	.62	.54	.60	.52	.65	.55	.87	.82	1.30
September	.62	.54	.60	.52	.66	.56	.87	.83	1.30
October	.61½	.53½	.60	.52	.67	.57	.87	.84	1.30
November	.60	.52	.60	.52	.67	.57	.93	.90	1.38
December	.60	.52	.60	.52	.67	.57	1.04	1.02	1.45
Average	.646	.566	.60	.52	.637	.546	.853	.786	1.288

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WELL RECORD.

In the following tables is given the well record for Illinois from 1909 to 1913, inclusive:

Number of wells completed in Illinois, 1909–1913, by counties.

County.	Oil.					Dry.					Total completed.[a]				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Bond	....	1	....	....	....	....	5	9	....	....	....	7	10	....	....
Clark	134	80	45	50	169	47	28	25	12	35	181	112	72	62	208
Clinton	....	....	123	35	14	....	3	49	13	5	....	3	172	48	19
Coles	9	4	2	1	3	3	1	....	5	3	12	5	2	6	6
Crawford	1,738	950	369	310	540	355	214	93	96	110	2,093	1,210	481	414	669
Cumberland	23	13	6	42	49	10	2	7	8	11	33	17	13	50	61
Edgar	2	....	....	....	....	4	1	1	....	....	6	2	1	....	....
Hancock	....	1	....	....	....	....	....	....	....	....	....	1	....	....	....
Jackson	1	....	....	1	....	2	2	....	4	2	3	2	....	6	2
Jasper	7	4	3	....	2	11	4	2	1	....	18	8	5	1	2
Lawrence	668	594	466	495	538	56	79	38	77	69	724	689	523	586	663
Macoupin	1	....	2	1	3	8	2	....	....	6	9	2	2	1	9
Madison	1	....	....	....	....	1	1	1	4	....	2	1	1	4	....
Marion	6	34	44	22	21	17	26	11	4	1	23	60	55	26	22
Randolph	2	....	....	....	....	10	....	....	1	....	12	....	....	1	....
Saline	1	....	....	....	....	1	1	....	....	2	2	1	....	....	2
Wabash	....	....	....	22	24	....	....	....	20	24	....	....	....	42	48
Miscellaneous	....	....	1	1	....	33	24	27	12	10	33	29	28	13	10
Total	2,593	1,681	1,061	980	1,363	[a]558	[b]393	[b]263	[b]257	[b]278	3,151	2,149	1,365	1,260	1,721

[a] Including gas wells. [b] Not including gas wells.

Number of oil wells and dry holes drilled in Illinois in 1913, by counties and months.

County.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Clark	3	1	5	..	8	4	7	..	17	1	17	6	12	8	22	6	18	3	13	2	29	3	18	1	169	35	50	12
Clinton	2	..	3	1	1	..	..	..	2	..	..	1	1	1	1	1	..	..	..	1	2	..	2	..	14	5	35	13
Coles	..	..	..	..	1	..	..	..	..	..	..	..	1	..	..	1	1	..	1	..	..	..	1	..	3	1	3	1	5
Crawford	39	7	24	6	28	3	27	6	52	8	39	9	56	8	41	21	65	9	67	11	34	12	68	10	540	110	310	96
Cumberland	5	..	5	..	2	..	3	1	8	2	7	7	10	1	1	..	4	..	1	..	..	..	3	..	49	11	42	8
Jackson	..	..	..	1	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	2	1	4
Jasper	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	2	..	..	1
Lawrence	49	8	42	5	30	3	51	4	56	5	45	5	55	7	46	6	55	4	62	11	47	7	..	4	538	69	495	77
Macoupin	..	..	..	..	..	..	..	..	..	..	..	..	1	..	1	..	..	..	1	5	..	1	..	..	3	6	1	..
Madison	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4
Marion	1	..	1	1	1	..	2	..	1	..	2	..	2	..	2	..	..	..	5	..	2	..	2	..	21	1	22	4
Randolph	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
Saline	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..
Wabash	7	7	2	7	1	..	2	2	1	2	2	1	2	1	2	2	2	..	1	1	1	1	1	..	24	24	22	20
Miscellaneous	..	..	..	1	..	1	..	..	..	3	..	3	..	1	..	1	..	..	..	..	..	..	..	..	..	10	1	12
Total	106	23	83	22	71	12	92	13	137	21	112	35	139	28	116	38	145	16	151	31	115	24	96	15	1,363	278	980	257

Number of oil wells drilled in Illinois, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	172	177	171	225	276	289	296	246	232	192	173	144	2,593
1910	94	115	99	116	149	161	129	198	186	168	138	128	1,681
1911	83	65	56	66	85	105	97	119	101	91	104	89	1,061
1912	74	58	44	54	66	96	77	95	88	124	107	102	980
1913	106	83	71	92	137	112	139	116	145	151	115	96	1,363

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Number of dry holes drilled in Illinois, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	41	47	45	38	45	53	50	57	50	48	52	32	[a] 558
1910	9	36	24	31	35	44	37	40	42	29	26	30	[b] 393
1911	16	16	10	13	31	37	24	25	34	16	23	18	[b] 263
1912	7	15	8	17	21	24	44	30	13	21	31	26	[b] 257
1913	23	22	12	13	21	35	28	38	16	31	24	15	[b] 278

[a] Including gas wells. [b] Not including gas wells.

Total number of wells completed in Illinois, 1909–1913, by months.[a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	213	224	216	263	321	342	346	303	282	242	223	176	3,151
1910	111	158	128	157	192	211	172	245	234	198	177	166	2,149
1911	105	89	70	81	117	147	127	150	135	107	129	108	1,365
1912	81	71	54	74	91	122	123	126	104	146	139	129	1,260
1913	131	107	89	105	159	153	170	156	163	181	143	164	1,721

[a] Including gas wells.

Initial daily production of new wells completed in Illinois in 1913, by counties and months, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total, 1913	Total, 1912
Clark	50	85	152	101	190	169	214	399	272	130	435	413	2,610	1,178
Clinton	15	18	20	.....	18	.....	15	10	.....	.....	30	8	134	1,127
Coles	.....	.....	.....	.....	.....	.....	.....	.....	50	5	.....	20	75	5
Crawford	855	855	464	413	732	668	1,067	776	988	1,332	860	980	9,990	7,175
Cumberland	60	80	41	25	95	81	151	3	22	10	.....	27	595	800
Jackson	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
Jasper	.....	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	25	30	.....
Lawrence	2,795	2,795	1,595	2,953	3,075	2,625	3,025	2,153	3,275	2,966	2,189	2,870	32,316	51,975
Macoupin	.....	.....	.....	.....	.....	.....	40	100	.....	25	.....	.....	165	3
Madison	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Marion	10	15	15	60	25	40	55	60	.....	125	52	35	492	610
Randolph	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Saline	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wabash	215	33	50	150	35	135	70	80	55	50	75	50	998	.....
Miscellaneous	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,810
Total	4,000	3,886	2,337	3,702	4,170	3,718	4,637	3,581	4,662	4,643	3,641	4,428	47,405	65,686

Total and average initial daily production of new wells in Illinois, 1909–1913, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Bond	.....	25	.....	.....	.....	.....	25.0	.....	.....	.....
Clark	3,219	1,802	771	1,178	2,610	24.0	22.5	17.1	23.6	15.4
Clinton	.....	.....	11,681	1,127	134	.....	.....	95.0	32.2	9.6
Coles	95	65	10	5	75	10.6	16.3	5.0	5.0	25.0
Crawford	44,379	26,382	9,802	7,175	9,990	25.5	27.8	26.6	23.1	18.5
Cumberland	558	162	100	800	595	24.3	12.5	16.7	19.0	12.1
Edgar	10	.....	.....	.....	.....	5.0	.....	.....	.....	.....
Hancock	.....	5	.....	.....	.....	.....	5.0	.....	.....	.....
Jackson	3	.....	.....	3	.....	3.0	.....	.....	3.0	.....
Jasper	50	40	20	.....	30	7.1	10.0	6.7	.....	15.0
Lawrence	41,056	61,015	40,432	51,975	32,316	61.5	102.7	86.8	105.0	60.1
Macoupin	5	.....	7	3	165	5.0	.....	3.5	3.0	55.0
Madison	10	.....	.....	.....	.....	10.0	.....	.....	.....	.....
Marion	223	3,760	4,025	610	492	37.2	110.6	91.5	27.7	23.4
Randolph	145	.....	.....	.....	.....	72.5	.....	.....	.....	.....
Saline	3	.....	.....	.....	.....	3.0	.....	.....	.....	.....
Wabash	.....	.....	.....	2,235	998	.....	.....	101.6	41.6	.....
Miscellaneous	.....	.....	3	575	.....	.....	.....	3.0	575.0	.....
Total	89,756	93,256	66,851	65,686	47,405	34.6	55.5	63.0	67.0	34.8

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Total initial daily production of new wells in Illinois, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909.....	5,080	4,833	5,018	5,237	7,681	9,050	9,820	8,661	8,324	8,904	9,628	7,540	89,756	7,479
1910.....	5,331	6,840	5,593	7,260	8,091	9,267	6,396	10,042	8,419	10,133	8,832	7,062	93,256	7,771
1911.....	5,677	3,512	3,909	5,587	5,132	5,850	9,058	7,535	6,551	4,782	5,826	3,432	66,851	5,571
1912.....	3,894	4,367	2,232	3,768	4,013	10,761	6,879	6,114	4,679	7,367	7,104	4,508	65,686	5,474
1913.....	4,000	3,886	2,337	3,702	4,170	3,718	4,637	3,581	4,662	4,643	3,641	4,428	47,405	3,950

MID-CONTINENT OIL FIELD.

PRODUCTION.

For commercial purposes it is convenient to group under the title "Mid-Continent oil field" the oil pools of Kansas, Oklahoma, Caddo, De Soto, La., and northern Texas. In this grouping the only new additions are the De Soto field, south of Shreveport, La. and the Moran field in northern Texas. The De Soto production is included with the Caddo field, and Moran's production is included with Electra. The description of these new developments is given farther on under the appropriate States.

The Mid-Continent field declined in 1912 as compared with the production in 1911, owing to the decline in Oklahoma, which was not offset by increase in the other divisions of the field. In 1913 every division of the Mid-Continent field increased, with a resulting total production for the field of 84,920,225 barrels, as compared with 65,473,345 barrels in 1912. The greatest increase was in Oklahoma.

Production of petroleum in the Mid-Continent field in 1912 and 1913, by months, in barrels.

Month.	1912					1913				
	Kansas.	Oklahoma.	Northern Texas.	Caddo, La.	Total.	Kansas.	Oklahoma.	Northern Texas.	Caddo, La.	Total.
Jan...	100,228	3,992,225	312,319	550,691	4,955,463	160,899	5,003,741	563,629	542,905	6,271,174
Feb...	108,160	3,836,382	304,397	646,488	4,895,427	161,306	4,689,487	537,780	562,863	5,951,436
Mar...	115,833	4,075,506	383,966	583,518	5,158,823	176,134	5,200,619	626,642	717,963	6,721,358
Apr...	120,297	3,929,944	394,327	700,594	5,145,162	184,231	5,267,004	646,958	860,274	6,958,467
May..	131,757	4,288,801	469,802	648,826	5,539,186	184,093	5,613,275	707,308	968,538	7,473,214
June..	129,488	4,012,952	427,967	617,267	5,187,674	183,156	5,321,915	774,509	1,010,049	7,289,629
July ..	141,777	4,364,329	458,701	592,223	5,557,030	194,637	5,320,234	848,714	953,530	7,317,115
Aug...	148,783	4,619,251	454,533	583,805	5,806,372	200,304	5,050,977	863,157	802,200	6,916,638
Sept..	144,672	4,342,560	465,039	593,422	5,545,693	209,082	5,188,563	887,324	812,062	7,097,031
Oct...	152,915	4,861,929	535,919	562,616	6,113,379	217,392	5,558,189	936,438	905,558	7,617,577
Nov...	131,844	4,429,295	529,783	550,887	5,641,809	234,381	5,580,288	905,928	814,545	7,535,142
Dec...	167,042	4,673,897	538,776	547,612	5,927,327	269,414	5,785,092	885,865	831,073	7,771,444
Total.	1,592,796	51,427,071	5,275,529	7,177,949	65,473,345	2,375,029	63,579,384	9,184,252	9,781,560	84,920,225

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Production of petroleum in the Mid-Continent field, 1889–1913, in barrels.

Year.	Production.	Percentage of total production.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).	Value.	Yearly average price per barrel.
1889	500	.....	.....	.....	$2,500	$5.000
1890	1,200	.....	+ 700	+140.00	8,400	7.000
1891	1,430	.....	+ 230	+ 19.17	9,950	6.958
1892	5,080	.....	+ 3,650	+255.24	5,480	1.079
1893	18,010	0.04	+ 12,930	+254.53	18,060	1.003
1894	40,130	.08	+ 22,120	+122.82	40,810	1.017
1895	44,467	.08	+ 4,337	+ 10.81	26,910	.605
1896	115,141	.19	+ 70,674	+158.93	52,587	.457
1897	147,648	.24	+ 32,507	+ 28.23	71,914	.487
1898	616,600	1.11	+ 468,952	+317.62	305,875	.496
1899	738,183	1.29	+ 121,583	+ 19.72	523,068	.709
1900	917,225	1.44	+ 179,042	+ 24.25	945,992	1.031
1901	989,496	1.43	+ 72,471	+ 7.90	778,096	.787
1902	986,720	1.12	− 2,976	− .30	745,803	.756
1903	1,573,065	1.57	+ 586,365	+ 59.42	1,645,936	1.046
1904	6,186,629	5.28	+ 4,613,544	+293.28	5,859,982	.947
1905	12,533,777	9.30	+ 6,347,148	+102.60	6,908,002	.551
1906	22,839,911	18.05	+10,306,134	+ 82.23	10,357,923	.454
1907	46,896,267	28.23	+24,056,356	+105.33	19,239,085	.410
1908	48,823,747	27.35	+ 1,927,480	+ 4.11	19,134,658	.392
1909	50,833,740	27.75	+ 2,009,993	+ 4.12	18,863,436	.371
1910	59,217,582	28.26	+ 8,383,842	+ 16.49	23,163,676	.391
1911	66,595,477	30.21	+ 7,377,895	+ 12.46	31,928,208	.479
1912	65,473,345	29.48	− 1,122,132	− 1.68	45,300,669	.692
1913	84,920,225	34.18	+19,446,880	+ 29.70	80,767,758	.951
Total	470,515,815	15.33	.....	.....	266,704,778	.567

Production of petroleum in the Mid-Continent field in 1912 and 1913, by States, showing increase and percentage of increase, in barrels.

State.	Production.		Increase.	Percentage increase.
	1912	1913		
Kansas	1,592,796	2,375,029	782,233	49.11
Oklahoma	51,427,071	63,579,384	12,152,313	23.63
Northern Texas	5,275,529	9,184,252	3,908,723	74.08
Caddo, La.	7,177,949	9,781,560	2,603,611	36.27
Total	65,473,345	84,920,225	19,446,880	29.70

Production, value, and average price per barrel of petroleum in the Mid-Continent field, 1904–1913, by States, in barrels.

Year.	Kansas and Oklahoma.			Northern Texas.		
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.
1904	5,617,527	$5,447,622	$0.970	569,102	$412,360	$0.724
1905	12,013,495	6,546,398	.545	520,282	361,604	.695
1906	21,718,648	9,615,198	.443	1,117,905	740,542	.662
1907	45,933,649	18,478,658	.402	912,618	721,577	.791
1908	47,600,546	18,441,538	.387	723,264	479,072	.662
1909	49,122,982	17,920,623	.364	681,940	393,732	.577
1910	53,157,386	20,367,423	.383	969,403	505,396	.521
1911	57,348,456	27,060,523	.472	2,251,193	1,213,960	.539
1912	53,019,867	35,768,302	.674	5,275,529	4,112,826	.779
1913	65,964,413	61,330,231	.937	9,184,252	9,125,185	.992

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Production, value, and average price per barrel of petroleum in the Mid-Continent field, 1904–1913, by States, in barrels—Continued.

Year.	Caddo, La.			Total.		
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.
1904				6,186,629	$5,859,962	$0.947
1905				12,533,777	6,908,002	.551
1906	3,358	$2,183	$0.650	22,839,911	10,357,923	.454
1907	50,000	38,850	.777	46,896,267	19,239,065	.410
1908	499,937	214,048	.428	48,823,747	19,134,658	.392
1909	1,028,818	549,061	.533	50,833,740	18,863,436	.371
1910	5,090,793	2,290,857	.....	59,217,582	23,163,676	.391
1911	6,995,828	3,653,725	.522	66,595,477	31,928,308	.479
1912	7,177,949	5,419,541	.755	65,473,345	45,300,669	.692
1913	9,781,560	9,812,342	1.003	84,920,225	80,767,758	.951

Production of petroleum in the Mid-Continent oil field, 1909–1913, by months and years, in barrels.

Month.	1909	1910	1911	1912	1913
January	4,072,631	4,556,738	4,919,620	4,955,463	6,271,174
February	3,652,477	4,028,540	4,683,538	4,896,427	5,951,436
March	4,225,436	5,161,294	7,080,646	5,158,823	6,721,358
April	3,925,727	5,563,228	5,952,082	5,145,162	6,958,467
May	4,259,114	5,117,565	5,742,341	5,539,186	7,473,214
June	4,620,111	5,248,177	5,584,423	5,187,674	7,299,629
July	4,267,179	5,048,983	5,488,403	5,557,030	7,317,115
August	4,371,422	4,836,711	5,386,153	5,806,372	6,916,638
September	4,474,618	5,115,361	5,466,628	5,545,693	7,097,031
October	4,264,225	5,121,995	5,680,980	6,113,379	7,617,577
November	4,419,409	4,677,634	5,352,694	5,641,809	7,535,142
December	4,281,391	4,741,356	5,258,069	5,927,327	7,771,444
Total	50,833,740	59,217,582	66,595,477	65,473,345	84,920,225

Average daily production of petroleum in the Mid-Continent oil field each month, 1909–1913, by months and years, in barrels.

Month.	1909	1910	1911	1912	1913
January	131,375	146,992	158,697	159,206	202,296
February	130,466	143,876	167,269	168,808	212,551
March	136,304	166,493	228,408	166,414	216,818
April	130,858	185,441	198,403	171,505	231,949
May	137,391	165,083	185,234	178,683	241,071
June	154,004	174,939	186,147	172,932	242,988
July	149,264	162,870	177,045	179,259	236,036
August	141,013	156,023	173,747	187,302	223,117
September	149,154	170,512	182,221	184,856	236,568
October	137,556	165,226	183,257	197,206	245,728
November	147,314	155,931	178,423	188,060	251,171
December	138,109	152,947	169,615	191,204	250,692
Average	139,270	162,240	182,453	178,889	232,658

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PIPE-LINE RUNS, DELIVERIES, AND STOCKS.

Pipe-line runs and deliveries to trade of petroleum from the Mid-Continent field, by months, in barrels, in 1913, and stocks at end of each month.

Month.	Runs.	Deliveries.	Stocks.
December 31, 1912			51,537,779
January	6,271,174	5,280,230	52,528,723
February	5,951,436	5,823,690	52,656,469
March	6,721,358	6,202,572	53,175,255
April	6,958,467	6,456,718	53,677,004
May	7,473,214	7,189,648	53,960,570
June	7,289,629	6,501,766	54,748,433
July	7,317,115	6,666,738	55,398,810
August	6,916,638	6,666,782	55,648,666
September	7,097,631	6,906,896	55,838,801
October	7,617,577	7,324,808	56,131,570
November	7,535,142	6,662,930	57,003,782
December	7,771,444	7,383,380	57,391,846
Total	84,920,225	79,066,158	

Plate IV shows the relations of the total production and stocks of oil in the Mid-Continent field to the prices for Kansas and Oklahoma oil from 1909 to 1913. The two lines for 1909 and part of 1910 show the prices for two grades of oil, the upper line being for oil with a gravity of 30° Baumé or lighter and the lower line for heavier oils.

PRICES.

The following table shows the changes in prices of Mid-Continent oil per barrel in 1911, 1912, and 1913, with the dates on which the changes were made:

Prices paid for Mid-Continent oil per barrel in 1911–1913, with the dates on which the changes were made.

Date.	Kansas and Oklahoma.	Northern Texas.				Caddo, La.	Date.	Kansas and Oklahoma.	Northern Texas.				Caddo, La.
		Corsicana (light).	Henrietta.	Powell (heavy).	Electra.				Corsicana (light).	Henrietta.	Powell (heavy).	Electra.	
1911.							1912.						
Jan. 1	$0.42	$0.58	$0.55	$0.50	.....	$0.42	July 18	.....	$0.70	$0.70	.....	$0.70	.....
Jan. 2	.44	.....	.....	.....	.....	.....	Sept. 10	.....	.....	.....	$0.60	.....	$0.60–$0.80
Jan. 3	.....	.....	.....	.....	.....	.44	Oct. 25	.....	.....	.....	.65	.....	.....
Mar. 14	.....	.....	.....	.....	.....	.44–.50	Nov. 7	$0.73	.....	.....	.....	.....	.....
May 2	.46	.....	.....	.....	.....	.....	Nov. 9	.....	.....	.....	.....	.....	.60– .83
June 14	.48	.....	.....	.....	.....	.50–.60	Nov. 14	.....	.75	.75	.....	.75	.....
Aug. 9	.....	.....	.....	.....	.....	.40–.60	Nov. 27	.76	.....	.....	.....	.....	.....
Sept. 15	.50	.....	.....	.....	.....	.40–.62	Dec. 11	.78	.....	.....	.....	.....	.....
1912.							Dec. 12	.....	.....	.....	.....	.....	.60– .88
Jan. 1	.50	.50	.50	.50	$0.50	.40–.62	Dec. 14	.....	.80	.80	.70	.80	.60– .91
Jan. 2	.53	.....	.....	.....	.....	.....	Dec. 16	.80	.....	.....	.....	.....	.....
Jan. 4	.....	.....	.....	.....	.....	.40–.65	Dec. 24	.83	.....	.....	.....	.....	.....
Jan. 15	.55	.....	.....	.....	.....	.....	Dec. 26	.....	.83	.88	.....	.88	.....
Jan. 18	.....	.....	.....	.....	.....	.40–.67	1913.						
Jan. 26	.57	.....	.....	.....	.....	.....	Jan. 1	.83	.83	.88	.70	.88	.60– .91
Jan. 27	.....	.....	.....	.....	.....	.40–.69	Jan. 7	.....	.....	.....	.....	.....	.70– .93
Feb. 1	.....	.55	.55	.....	.55	.....	Jan. 9	.....	.90	.90	.....	.90	.....
Feb. 2	.....	.....	.....	.....	.....	.40–.72	Jan. 10	.....	.88	.88	.....	.88	.....
Feb. 5	.60	.....	.....	.....	.....	.....	Jan. 13	.....	.90	.90	.....	.90	.....
Mar. 1	.....	.....	.....	.55	.....	.....	Jan. 29	.88	.95	.95	.....	.95	.....
Apr. 10	.62	.....	.....	.....	.....	.....	Feb. 1	.....	.....	.....	.....	.....	.70– .98
Apr. 16	.64	.60	.60	.....	.60	.....	Apr. 7	.....	.....	.....	.80	.....	.....
Apr. 17	.....	.....	.....	.....	.....	.40–.75	July 7	.93	.....	.....	.....	.....	.75– 1.00
May 7	.66	.....	.....	.....	.....	.....	July 21	.98	.....	.....	.....	.....	.....
May 17	.68	.....	.....	.....	.....	.....	July 24	.....	1.00	1.00	.....	1.00	.....
May 20	.....	.65	.65	.....	.65	.40–.77	Aug. 19	1.03	.....	.....	.....	.....	.....
June 20	.....	.....	.....	.....	.....	.55–.77	Aug. 22	.....	.....	.....	.....	.....	.75– 1.05
July 15	.....	.....	.....	.....	.....	.55–.80	Aug. 25	.....	1.05	1.05	.....	1.05	.....
July 16	.70	.....	.....	.....	.....	.....							

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In the following table is given the average price per month of the different oils of the Mid-Continent field during the years 1912 and 1913:

Average monthly prices of Mid-Continent petroleum in 1912 and 1913, per barrel.

1912

Month.	Kansas and Oklahoma.	Northern Texas.				Caddo, La.
		Corsicana (light).	Henrietta.	Powell (heavy).	Electra.	
January	$0.54	$0.50	$0.50	$0.50	$0.50	$0.40 –$0.66
February	.60	.55	.55	.50	.55	.40 – .71
March	.60	.55	.55	.55	.55	.40 – .72
April	.62	.55	.55	.55	.55	.40 – .73
May	.67	.60	.60	.55	.60	.40 – .76
June	.68	.65	.65	.55	.65	.46 – .77
July	.69	.65	.65	.55	.65	.55 – .75
August	.70	.70	.70	.55	.70	.55 – .80
September	.70	.70	.70	.59	.70	.59 – .80
October	.70	.70	.70	.61	.70	.60 – .80
November	.73	.70	.70	.65	.70	.60 – .83
December	.79	.75	.75	.68	.75	.60 – .88
Average	.668	.634	.634	.569	.634	.496– .768

1913

January	$0.83	$0.88	$0.88	$0.70	$0.88	$0.68 –$0.93
February	.88	.95	.95	.70	.95	.70 – .98
March	.88	.95	.95	.70	.95	.70 – .98
April	.88	.95	.95	.78	.95	.70 – .98
May	.88	.95	.95	.80	.95	.70 – .98
June	.88	.95	.95	.80	.95	.70 – .98
July	.92	.96	.96	.80	.96	.74 – .94
August	1.00	1.01	1.01	.80	1.01	.75 – 1.02
September	1.03	1.05	1.05	.80	1.05	.75 – 1.05
October	1.03	1.05	1.05	.80	1.05	.75 – 1.05
November	1.03	1.05	1.05	.80	1.05	.75 – 1.05
December	1.03	1.05	1.05	.80	1.05	.75 – 1.05
Average	.939	.983	.983	.773	.983	.723– .991

WELL RECORD.

Number of wells completed in the Mid-Continent field, 1909–1913, by districts.

District.	Oil.					Dry.					Total completed.[a]				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Kansas	69	85	172	536	1,422	106	82	96	160	260	558	428	418	949	2,016
Oklahoma	2,742	3,188	3,294	4,712	6,965	380	408	489	843	1,308	3,279	3,777	4,087	5,993	8,851
North Texas	116	108	84	299	581	45	[a] 82	38	124	208	175	190	126	434	799
Caddo, La.[b]	69	124	246	239	356	33	54	63	62	92	121	[c] 226	341	353	518
Total	2,996	3,505	3,796	5,786	9,324	564	626	686	1,189	1,868	4,133	4,621	4,972	7,729	12,184

[a] Including gas wells.
[b] Includes in 1913 Bossier, De Soto, and Sabine parishes.
[c] Includes Marion County, Tex.

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Number of oil wells and dry holes drilled in the Mid-Continent field in 1913, by districts and months.

District.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Kansas	44	6	69	9	61	12	63	13	97	29	128	30	147	31
Oklahoma	375	69	433	61	401	67	470	46	624	111	664	135	647	180
North Texas	38	27	31	25	35	12	55	16	57	18	61	19	47	17
Caddo, La [a]	31	9	20	3	17	9	36	1	33	4	14	7	39	9
Total	488	111	553	98	514	100	624	76	811	162	867	191	880	237

District.	Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Kansas	155	20	133	23	147	32	184	24	194	31	1,422	260	536	160
Oklahoma	691	130	626	97	656	125	669	122	709	165	6,965	1,308	4,712	843
North Texas	56	20	41	9	48	10	68	25	44	10	581	208	299	124
Caddo, La [a]	25	6	39	10	30	10	32	13	40	11	356	92	239	62
Total	927	176	839	139	881	177	953	184	987	217	9,324	1,868	5,786	1,189

[a] Includes in 1913 Bossier, De Soto, and Sabine parishes.

Number of oil wells drilled in the Mid-Continent field, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	274	265	307	343	339	246	225	211	196	182	170	164	[a] 2,996
1910	208	265	287	317	336	325	253	261	265	308	326	230	[b] 3,505
1911	254	290	349	413	378	279	254	243	262	249	317	262	[b] 3,796
1912	148	296	313	423	448	564	538	533	510	544	615	555	5,487
1913	493	558	525	633	817	876	892	939	843	885	955	989	9,405

[a] South Bosque, Tex., and Caddo, La., not given by months.
[b] Caddo, La., not given by months.

Number of dry holes drilled in the Mid-Continent field, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	53	32	49	62	63	61	44	39	27	34	44	36	[a] 573
1910	34	62	59	60	48	52	50	25	67	43	40	32	[b] 626
1911	45	29	39	71	68	74	57	47	34	39	61	50	[b] 685
1912	32	75	56	90	92	101	83	75	99	136	139	87	1,065
1913	114	105	100	91	163	201	243	180	141	178	185	224	1,925

[a] South Bosque, Tex., and Caddo, La., not given by months.
[b] Caddo, La., not given by months.

Total number of wells completed in the Mid-Continent field, 1909–1913, by months. [a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	370	330	408	435	441	348	300	286	263	267	289	269	[b] 4,133
1910	307	387	386	417	426	427	332	306	357	384	383	283	[c] 4,631
1911	328	344	421	528	482	417	364	304	351	322	407	363	4,972
1912	203	420	406	571	604	745	674	676	679	767	848	702	7,295
1913	677	728	671	782	1,090	1,199	1,225	1,202	1,068	1,149	1,226	1,306	12,323

[a] Including gas wells.
[b] South Bosque, Tex., and Caddo, La., not given by months.
[c] Caddo, La., not given by months.

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Initial daily production of new wells completed in the Mid-Continent field in 1913, by districts and months, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total, 1913.	Total, 1912.
Kansas	860	1,065	1,003	1,897	1,548	1,918	1,945	2,250	2,283	2,501	2,857	2,340	22,467	7,245
Oklahoma	19,220	19,505	21,615	29,847	27,139	32,192	26,071	27,897	27,267	30,953	29,211	43,133	334,050	228,886
North Texas	2,726	3,366	2,966	1,909	6,258	9,720	7,391	4,593	5,605	5,092	5,291	2,498	57,435	28,213
Caddo, La	6,499	11,615	10,585	20,865	24,246	11,636	12,735	19,189	6,250	9,890	3,397	15,048	151,955	84,098
Total	29,305	35,551	36,189	54,518	59,191	55,466	48,142	53,929	41,405	48,436	40,756	63,019	565,907	348,442

Total and average initial daily production of new wells in the Mid-Continent field, 1909–1913, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Kansas	1,309	1,897	3,271	7,245	22,467	19.0	22.3	19.0	13.5	15.8
Oklahoma	206,454	226,638	262,333	228,886	334,050	75.3	71.1	79.6	48.6	48.0
North Texas	1,177	1,683	19,180	28,213	57,435	10.8	15.6	228.3	94.3	98.9
Caddo, La	8,750	[a]139,945	169,123	84,098	[b]151,955	127.0	1,128.6	687.5	351.9	426.8
Total	217,690	370,163	453,907	348,442	565,907	72.7	105.6	119.6	60.2	60.7

[a] Includes Marion County, Tex. [b] Includes Bossier, De Soto, and Sabine parishes.

Total initial daily production of new wells in the Mid-Continent field, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909	21,795	21,915	21,445	21,121	21,457	18,383	16,675	15,608	14,349	11,802	12,543	11,847	[a]217,690	18,141
1910	15,840	18,080	21,057	19,110	19,758	27,462	15,204	16,906	19,305	18,899	18,187	20,400	[a]370,163	30,847
1911	23,525	26,970	40,855	31,168	28,828	24,225	16,968	12,934	17,274	20,754	22,738	18,545	[a]453,907	37,826
1912	19,283	22,437	24,429	37,573	24,592	22,099	23,971	30,153	36,468	38,877	37,573	30,987	348,442	29,037
1913	29,305	35,551	36,189	54,518	59,191	55,466	48,142	53,929	41,405	48,436	40,756	63,019	565,907	47,159

[a] Caddo, La., not given by months.

KANSAS.

DEVELOPMENT.

The low cost of leases in Kansas as compared with Oklahoma led to the drilling of more than twice as many wells as were drilled in 1912 and four times the number drilled in 1911. The results were more than satisfactory, for the initial production increased from 13.5 barrels per well in 1912 to 15.8 barrels in 1913. Montgomery County led in drilling activity, obtaining 867 wells; 442 wells were obtained in Chautauqua County, and 316 in Neosho. The wildcatting showed a tendency to spread to counties farther west. As a general result Kansas showed a gain of 49.11 per cent in quantity and of 105.19 per cent in value of product; the quantity rose from 1,592,796 barrels in 1912 to 2,375,029 barrels in 1913, and the total value from $1,095,698 to $2,248,283.

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PRODUCTION.

Production of petroleum in Kansas, 1909–1913, in barrels.

	1909	1910	1911	1912	1913
Quantity piped from wells in Kansas to refineries	466,298	388,013	307,750	367,878	456,633
Rail shipments in Kansas	52,261	21,590	28,122	6,624	27,744
Quantity piped from other wells in Kansas and sold	745,205	719,065	942,947	1,218,294	1,890,652
Total sales in Kansas	1,263,764	1,128,668	1,278,819	1,592,796	2,375,029
Total value	$491,633	$444,763	$608,756	$1,095,698	$2,248,283

WELL RECORD.

The following tables give the well record for Kansas from 1909 to 1913, inclusive:

Number of wells completed in Kansas, 1909–1913, by counties.

County.	Oil.					Dry.					Total completed.[a]				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Allen	16	13	30	50	154	35	14	10	6	11	151	78	59	58	171
Anderson	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....
Chautauqua	23	42	64	182	311	3	14	11	28	77	31	60	82	222	442
Elk	7	.....	.....	.....	.....	.....	.....	4	.....	.....	9	1	4	.....	.....
Franklin	.....	1	.....	18	54	1	.....	.....	.....	3	7	3	.....	18	58
Labette	.....	1	.....	2	.....	3	.....	.....	.....	.....	11	3	1	2	3
Montgomery	5	16	60	202	602	22	7	22	47	92	127	79	118	365	867
Neosho	18	9	16	62	257	17	17	22	23	22	100	87	59	115	316
Wilson	.....	1	2	18	40	24	27	27	52	45	113	108	94	156	139
Woodson	.....	.....	.....	1	2	.....	.....	.....	3	3	2	.....	.....	7	5
Miscellaneous	.....	2	.....	1	2	1	3	.....	1	2	6	9	1	6	15
Total	69	85	172	536	1,422	106	82	96	160	260	558	428	418	949	2,016

[a] Including gas wells.

Number of oil wells and dry holes drilled in Kansas in 1913, by counties, and months.

County.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen	4	1	5	2	3	..	10	..	5	1	13	..	12	..	17	1	16	..	18	4	26	..	25	3	154	11	50	6
Chautauqua	7	1	15	3	15	5	17	2	30	12	29	13	35	12	31	8	38	10	36	3	22	3	36	5	311	77	182	28
Franklin	2	..	4	..	4	..	2	..	3	1	3	..	4	..	12	..	2	..	3	1	7	1	8	..	54	3	18	....
Labette	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	....
Montgomery	21	3	33	4	25	3	11	5	37	9	56	14	75	7	47	6	52	7	55	11	89	11	101	12	602	92	202	47
Neosho	8	1	9	..	13	1	22	5	16	3	23	..	18	3	44	1	21	1	26	4	36	2	21	6	257	27	62	23
Wilson	2	..	3	..	1	3	1	1	6	3	3	2	3	9	4	5	4	5	7	7	4	6	2	4	40	45	18	52
Woodson	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	1	..	1	1	1	2	3	1	3
Miscellaneous	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	2	1	..	..	..	..	2	2	1	1
Total	44	6	69	9	61	12	63	13	97	29	128	30	147	31	155	20	133	23	147	32	184	24	194	31	1,422	260	536	160

Number of oil wells drilled in Kansas, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	3	3	11	9	12	8	5	2	4	5	3	4	69
1910	.....	5	3	4	5	2	8	7	12	14	11	14	85
1911	7	5	16	7	21	14	22	23	13	20	11	13	172
1912	4	11	10	23	37	46	60	80	56	63	81	65	536
1913	44	69	61	63	97	128	147	155	133	147	184	194	1,422

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Number of dry holes drilled in Kansas, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	14	8	11	7	6	8	9	7	6	13	12	5	106
1910	9	8	12	10	7	4	5	2	7	9	5	4	82
1911	8	5	7	7	10	10	9	9	2	7	15	7	96
1912	2	7	9	9	12	8	7	10	18	29	34	15	160
1913	6	9	12	13	29	30	31	20	23	32	24	31	260

Total number of wells completed in Kansas, 1909–1913, by months. [a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	54	38	63	39	45	49	36	36	39	55	58	46	558
1910	45	48	42	40	34	29	36	25	30	47	28	24	428
1911	29	20	36	27	43	53	41	23	41	40	26	39	418
1912	9	27	27	46	75	72	77	115	106	138	155	102	949
1913	75	107	88	96	172	190	202	207	185	209	236	249	2,016

[a] Including gas wells.

Initial daily production of new wells completed in Kansas in 1913, by counties and months, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total, 1913.	Total, 1912.
Allen	75	90	50	325	75	254	188	243	492	348	453	367	2,960	632
Chautauqua	295	330	280	475	553	632	691	772	749	885	878	818	7,358	2,963
Franklin	15	55	70	125	18	39	50	158	41	22	90	65	748	155
Montgomery	245	340	293	147	434	646	646	404	469	665	855	727	5,871	2,522
Neosho	220	220	295	800	435	307	335	612	500	530	564	350	5,168	693
Wilson	10	30	15	25	33	35	35	61	32	44	17	5	342	255
Woodson	.....	.....	.....	.....	.....	5	.....	.....	.....	.....	.....	8	13	5
Miscellaneous	.....	.....	.....	.....	.....	.....	.....	.....	.....	7	.....	.....	7	20
Total	860	1,065	1,003	1,897	1,548	1,918	1,945	2,250	2,283	2,501	2,857	2,340	22,467	7,245

Total and average initial daily production of new wells in Kansas, 1909–1913, by counties, in barrels.

County.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Allen	251	210	353	632	2,960	15.7	16.2	11.8	12.6	19.2
Chautauqua	475	1,100	1,355	2,963	7,358	20.7	26.2	21.2	16.3	23.7
Elk	110	.....	.....	.....	.....	15.7	.....	.....	.....	.....
Franklin	.....	5	.....	155	748	.....	5.0	.....	8.6	13.9
Labette	.....	20	.....	15	.....	.....	20.0	.....	7.5	.....
Montgomery	113	382	1,300	2,522	5,871	22.6	23.9	21.7	12.5	9.8
Neosho	360	130	208	693	5,168	20.0	14.4	13.0	11.2	20.1
Wilson	.....	10	55	255	342	.....	10.0	27.5	14.2	8.6
Woodson	.....	.....	.....	5	13	.....	.....	.....	5.0	6.5
Miscellaneous	.....	40	.....	5	7	.....	20.0	.....	5.0	3.5
Total	1,309	1,897	3,271	7,245	22,467	19.0	22.3	19.0	13.5	15.8

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Total initial daily production of new wells in Kansas, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909.....	50	45	225	166	220	130	98	55	85	65	70	100	1,309	109
1910.....	.....	95	65	95	170	40	235	200	257	305	210	225	1,897	158
1911.....	155	90	304	161	438	255	285	363	265	380	265	310	3,271	273
1912.....	65	173	213	390	352	714	834	940	507	842	1,185	1,030	7,245	604
1913.....	860	1,065	1,003	1,897	1,548	1,918	1,945	2,250	2,283	2,501	2,857	2,340	22,467	1,872

OKLAHOMA.

DEVELOPMENT.

The history of the production of petroleum in Oklahoma during 1913 is one of continuous increase at an increasing rate from the beginning to the end of the year. As a result, the production of 1912, which was 51,427,071 barrels, valued at $34,672,604, increased to 63,579,384 barrels, valued at $59,581,948, in 1913. The percentage of increase in quantity was 23.63 and in value 71.83.

Perhaps the most significant feature of development as bearing upon the ultimate value of the Oklahoma fields is the fact that this increase was not the result of a flood of oil from any new pool; it was due rather to the exceptional development within known limits, and to the desire to extend the edges and thus prove the limits of a great many pools already well known. It is true that the Cushing pool was an unusual element in the development, but this field was discovered in 1912 and had received quite considerable development before the beginning of 1913. In addition to the Cushing contribution, the new development in the Osage region; the extension of the Hogshooter pool to the east and of the Shallow fields to the west; the developments between Bartlesville and the old Dewey pool; the developments in the immediate neighborhood of Tulsa, and the development of the new Wicey pool near Mounds had each a decided influence in the record-breaking production.

Cushing.—Without doubt the one single factor of more interest than any other was the development in the Cushing pool. In the first week in January, 1913, the Cushing pool was yielding 11,000 barrels a day; but the consumption in Oklahoma was so great thatstocks were drawn upon during January. By the end of that month the Cushing pool had increased to 20,000 barrels a day from about 120 wells. Many of the wells declined rapidly and a short life for the field was the general prediction. In the month of February, in spite of bad weather, drilling resulted in 67 wells being developed in the Cushing field alone. There were 62 oil wells, 4 gas wells, and only 1 failure. As a result the rate of production in the Cushing field increased to 21,500 barrels a day by February 10, to 25,000 barrels a day by February 20, and to 28,000 barrels a day by the end of the month. The wells in the pool, as already noted, declined rapidly, so that by March 10 the daily yield was down to 25,000 barrels again, and to 23,000 barrels by March 18. This production and the rapid drilling in other parts of the State had led, however, to an increase in stocks instead of the decrease at the beginning of the year, and early in March 11,000 barrels a day were being added to storage. The decline in the Cushing pool continued in April down to 18,000 barrels a day and by June 10 the field only

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yielded 16,000 barrels a day. The gusher characteristics of the new wells did not equal the rapid decline in the old ones. In August rapid drilling operations brought the daily production up again to 25,000 barrels and by September 1 this had gone to 30,000 barrels, only to decline again by October 1 to 25,000 barrels, and by the end of October the daily rate was down to 23,000 barrels, again increasing in the following week, however. These fluctuations continued, the increase above the rate prevailing in the first half of the year being due to a northwestern extension in the pool, where wells showed greater staying powers than in the older portion.

December 9 brought a very decided change in the outlook for the Cushing pool. On that date the Prairie Oil & Gas Co. drilled a well in sec. 3, T. 17, R. 7, to the Bartlesville sand at a depth of 2,600 feet. This resulted in a very large gusher. It was the signal for general drilling to the Bartlesville sand, and the year for the Cushing pool closed with greater excitement in the extension of the pool than had been created by the discovery of the pool just a year before.

Healdton.—A second feature of greatest importance for the future of Oklahoma's oil production was the drilling of a well in the neighborhood of Healdton, Carter County, in September. On September 25, the Red River Oil Co. brought in a second well at a depth of 850 feet, a mile and a half north of Number One, which yielded 35 barrels a day. By November 1 this development had led to much excitement, involving the payment of large sums of money for leases in the Healdton region. Although the effect was not such as to increase the yield for 1913 to any great extent, the subsequent development in the Healdton field has been of the greatest importance in regard to conditions in 1914.

PRODUCTION.

The following table shows the production and sales of petroleum in Oklahoma from 1909 to 1913:

Production of petroleum in Oklahoma, 1909–1913, in barrels.

	1909	1910	1911	1912	1913
Quantity shipped from Glenn pool and sold	18,946,740	19,236,914	13,880,118	10,405,518	9,469,870
Quantity piped from other wells in Oklahoma and sold	28,330,313	32,124,072	41,783,947	40,732,128	52,192,881
Rail shipments (outside Glenn pool) in Oklahoma	582,165	667,732	405,572	289,425	1,916,633
Total sales in Oklahoma	47,859,218	52,028,718	56,069,637	51,427,071	63,579,384
Total value	$17,428,990	$19,922,660	$26,451,767	$34,672,604	$59,581,948

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Production of petroleum in Oklahoma in 1912 and 1913, by months, in barrels.

1912.

Month.	Runs from wells.		Shipped by rail and fuel consumption not included in pipe-line runs.	Total.
	Gulf, Prairie and Texas companies' pipe lines.	Alluwe, Chelsea, Cherokee, Muskogee, National Refining, Nowata, and other lines to refineries.		
January	3,477,588	480,335	34,302	3,992,225
February	3,328,570	486,518	21,294	3,836,382
March	3,547,455	505,791	22,280	4,075,506
April	3,408,534	493,341	28,069	3,929,944
May	3,722,122	528,055	38,624	4,288,801
June	3,462,517	528,213	22,222	4,012,952
July	3,815,577	523,939	24,813	4,364,329
August	4,041,753	555,784	21,714	4,619,251
September	3,781,135	545,454	15,971	4,342,560
October	4,243,964	594,144	23,821	4,861,929
November	3,835,125	577,959	16,211	4,429,295
December	4,061,952	582,734	29,211	4,673,897
Total	44,726,292	[a] 6,402,267	298,512	51,427,071

1913.

January	4,030,733	915,437	57,571	5,003,741
February	3,826,109	793,618	69,660	4,689,487
March	4,288,256	827,145	85,218	5,200,619
April	4,244,596	840,327	182,081	5,267,004
May	4,471,192	862,264	279,819	5,613,275
June	4,210,510	874,078	237,327	5,321,915
July	4,239,810	902,681	177,743	5,320,234
August	4,026,405	880,415	144,157	5,050,977
September	4,141,791	844,851	201,921	5,188,563
October	4,535,799	853,933	168,457	5,558,189
November	4,525,751	815,385	239,152	5,580,288
December	4,718,619	869,443	197,030	5,785,092
Total	51,259,571	[a] 10,279,577	2,040,236	63,579,384

[a] Quantity run by other lines averaged.

OSAGE COUNTY.

The following table gives a statement of the quantity of petroleum produced by the Indian Territory Illuminating Oil Co. and its sublessees from wells in Osage County from 1903 to 1913, inclusive:

Production of petroleum by the Indian Territory Illuminating Oil Co. and its sublessees from Jan. 1, 1903, to Dec. 31, 1913.

	Barrels.		Barrels.
1903	56,905	1909	4,516,524
1904	652,479	1910	5,892,970
1905	3,421,478	1911	11,707,676
1906	5,219,106	1912	8,169,158
1907	5,143,971	1913	9,009,996
1908	4,961,147		

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Total production and value of royalty oil and gas from wells in Osage County during the years 1912 and 1913.

1912.

Received by—	Total quantity produced.	Amount received by Osage Nation for royalty of one-eighth of production.
	Barrels.	
Prairie Oil & Gas Co	6,631,390	$550,162
Gulf Pipe Line Co	492,595	40,866
Uncle Sam Oil Co	94,714	7,858
Southwestern Refining Co	136,261	11,305
The Texas Co	809,501	67,158
Indian Territory Illuminating Oil Co	853	71
Barnsdall Oil Co	3,844	319
Total	8,169,158	677,739
Royalty received by Osage Nation for gas	.....	3,895
Total amount received by Osage Nation for oil and gas	.....	681,634

1913.

	Barrels.	
Prairie Oil & Gas Co	7,611,686	$875,453
Gulf Pipe Line Co	464,772	53,050
Uncle Sam Oil Co	132,620	14,918
Southwestern Refining Co	244,853	26,649
Texas Co	546,709	62,403
Sold by lessees for fuel	9,356	1,057
Total	9,009,996	1,033,530
Royalty received by Osage Nation for gas	.....	5,943
Total amount received by Osage Nation for oil and gas	.....	1,039,473

In the following table is shown the number of wells owned in Osage County by the Indian Territory Illuminating Oil Co. and its sublessees from 1903 to 1913, inclusive:

Oil and gas wells in Osage County, 1903–1913.

Total wells to—	Completed.	Productive.	Gas.	Dry.[a]
Jan. 1, 1903	30	17	2	11
Dec. 31, 1904	361	243	21	97
June 10, 1905	544	355	34	155
Dec. 31, 1905	704	462	45	197
June 10, 1906	862	569	55	238
Dec. 31, 1906	1,080	716	66	298
June 30, 1907	1,155	779	67	309
Dec. 31, 1907	1,277	837	71	369
Dec. 31, 1908	1,422	936	78	408
Dec. 31, 1909	1,574	1,027	81	466
Dec. 31, 1910	1,735	1,175	82	478
Dec. 31, 1911	2,233	1,562	90	581
Dec. 31, 1912	2,682	1,887	112	683
Dec. 31, 1913	3,307	2,323	145	839

[a] Wells which have been exhausted and abandoned in addition to wells that were dry when drilled in.

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GLENN POOL.

In the following table is given the production of petroleum in the Glenn pool (Creek County) for the last five years:

Estimated production and sales of petroleum from Glenn pool, 1909–1913, by months, in barrels.

Month.	1909	1910	1911	1912	1913
January	1,362,602	1,745,206	1,099,192	882,385	792,336
February	1,410,878	1,543,660	967,924	867,566	718,580
March	1,543,463	1,974,514	2,584,464	924,144	807,022
April	1,467,179	1,674,709	1,570,947	898,527	823,645
May	1,590,730	1,676,366	1,069,863	927,182	850,607
June	1,809,989	1,573,578	958,519	816,028	816,789
July	1,856,524	1,557,989	965,122	880,906	787,274
August	1,699,486	1,609,702	981,946	927,675	734,476
September	1,670,167	1,593,986	937,886	794,958	773,847
October	1,602,988	1,521,794	969,247	921,736	817,628
November	1,539,342	1,400,118	854,519	768,254	753,115
December	1,393,392	1,365,412	910,489	886,157	794,551
Total	18,946,740	19,236,914	13,880,118	10,495,518	9,469,870

WELL RECORD.

The following table gives the well record for Oklahoma for 1912 and 1913, by districts and pools:

Well record in Oklahoma in 1912 and 1913, by districts and pools.

District and pool.	1912					1913				
	Wells completed.			Initial daily production.		Wells completed.			Initial daily production.	
	Oil.	Dry.	Total.[a]	Total.	Average per well.	Oil.	Dry.	Total.[a]	Total.	Average per well.
Cherokee deep sand:				*Barrels.*	*Barrels.*				*Barrels.*	*Barrels.*
Bartlesville	499	45	584	11,716	23.5	829	75	948	19,412	28.4
Hogshooter	285	43	392	13,151	46.1					
Bird Creek	697	92	821	27,880	40.0	610	70	755	17,813	29.2
Copan-Ramsey	482	50	573	10,972	22.8	393	50	469	6,309	16.1
Collinsville	.....	.....	.....	.....	.....	122	49	205	8,129	66.6
Dewey	481	26	536	12,306	26.6	770	55	872	15,842	20.6
Total	2,444	256	2,906	76,025	31.1	2,724	299	3,249	67,505	24.8
Cherokee, shallow sand:										
Alluwe	544	47	594	7,460	13.7	.....	.....	.....	.....	.....
Chelsea						.....	.....	.....	.....	.....
Coody's Bluff	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Delaware-Childers	209	21	236	3,355	16.1	.....	.....	.....	.....	.....
Nowata	8	19	51	115	14.4	.....	.....	.....	.....	.....
Total	761	87	881	10,930	14.4	[b]1,071	[b] 139	[b]1,231	[b]17,672	16.5
Cleveland	196	46	253	33,903	173.0	187	68	262	15,787	84.4
Creek:										
Bald Hill	56	23	82	2,860	51.1	155	65	238	10,000	64.5
Beggs-Preston	36	27	67	4,860	135.0	75	51	145	14,163	188.8
Cushing	68	2	79	15,465	227.4	717	41	821	101,245	141.2
Glenn pool	159	41	228	9,815	61.7	740	186	989	31,595	426.9
Taneha	91	19	112	2,609	28.7					
Tulsa	174	76	310	11,360	65.3					
Morris-Okmulgee	122	74	219	15,056	123.4	336	130	491	19,335	57.5
Mounds	11	17	29	865	78.6	118	45	192	7,977	67.6
Muskogee	12	24	38	293	24.4	60	31	100	1,569	26.1
Sapulpa	33	11	48	1,495	45.3	(c)	(c)	(c)	(c)	.....
Schulter	90	30	134	12,910	142.4	203	105	337	7,912	39.9
Total	852	344	1,346	77,588	91.1	2,404	654	3,313	193,796	80.6
Osage	417	54	489	25,400	60.9	506	69	620	34,856	68.8
Ponca City	31	20	58	4,790	154.5	29	23	55	2,964	102.2
Carter County	.....	.....	.....	.....	.....	15	5	23	844	56.2
Miscellaneous	11	36	60	250	22.7	29	51	98	626	21.5
Grand total	4,712	843	5,993	228,886	48.6	6,965	1,308	8,851	334,050	47.9

[a] Including gas wells. [b] Not reported by districts. [c] Included in Glenn pool, Taneha, and Tulsa.

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Number of wells completed in Oklahoma, 1909–1913, by districts.

District.	Oil.					Dry.					Total completed.[a]				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Cherokee, deep	519	627	806	2,444	2,724	62	61	114	256	299	652	802	1,074	2,906	3,249
Cherokee, shallow	1,535	1,665	1,381	761	1,071	169	152	109	87	139	1,724	1,830	1,576	881	1,231
Creek	582	657	536	852	2,404	114	142	175	344	654	733	837	746	1,346	3,313
Cleveland	23	10	129	196	187	3	2	31	46	68	28	13	165	253	262
Osage	75	206	438	417	506	15	25	40	54	69	108	239	494	489	620
Ponca City	.....	.....	.....	31	29	.....	.....	.....	20	23	.....	.....	.....	58	55
Carter County	.....	.....	.....	.....	15	.....	.....	.....	.....	5	.....	.....	.....	.....	23
Miscellaneous	8	23	4	11	29	17	26	20	36	51	34	56	32	60	98
Total	2,742	3,188	3,294	4,712	6,965	380	408	489	843	1,308	3,279	3,777	4,087	5,993	8,851

[a] Including gas wells.

Number of oil wells and dry holes drilled in Oklahoma in 1913, by districts and months.

District.	Jan.		Feb.		Mar.		Apr.		May.		June		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Cherokee, deep	168	17	184	12	159	16	180	13	300	25	311	24	267	38
Cherokee, shallow	42	14	65	5	62	3	70	5	68	11	104	14	116	21
Creek	124	29	150	30	137	30	157	21	198	59	187	72	207	91
Cleveland	16	4	13	4	11	6	16	1	21	8	29	11	16	5
Osage	23	2	20	8	30	9	42	4	35	3	30	4	40	8
Ponca City	2	3	1	....	2	1	5	....	....	3	....	....	....	11
Carter County	....	....	....	....	....	1	....	....	....	....	1	1	....	....
Miscellaneous	....	....	....	2	....	1	....	2	2	2	2	9	1	6
Total	375	69	433	61	401	67	470	46	624	111	664	135	647	180

District.	Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Cherokee, deep	291	25	235	27	244	28	201	31	184	43	2,724	299	2,444	256
Cherokee, shallow	116	18	93	15	106	13	109	9	120	11	1,071	139	761	87
Creek	223	61	226	43	227	66	280	63	288	89	2,404	654	852	344
Cleveland	9	8	14	8	12	2	15	5	15	6	187	68	196	46
Osage	48	9	46	2	57	6	54	7	81	7	506	69	417	54
Ponca City	1	....	1	1	2	....	....	....	15	4	29	23	31	20
Carter County	1	....	3	....	3	....	3	1	4	2	15	5	.....	.....
Miscellaneous	2	9	8	1	5	10	7	6	2	3	29	51	11	36
Total	691	130	626	97	656	125	669	122	709	165	6,965	1,308	4,712	843

Number of oil wells drilled in Oklahoma in 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	271	260	296	330	309	223	203	202	180	167	147	154	2,742
1910	208	240	271	293	321	311	237	248	242	292	310	215	3,188
1911	245	278	329	393	356	265	225	217	240	222	294	280	3,294
1912	135	269	288	388	386	495	458	430	427	456	506	474	4,712
1913	375	433	401	470	624	664	647	691	626	656	669	709	6,965

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Number of dry holes drilled in Oklahoma, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	33	22	38	51	53	48	31	28	14	17	21	24	380
1910	25	48	41	41	36	40	31	17	50	28	28	23	408
1911	30	16	27	56	56	64	46	35	32	32	45	50	489
1912	28	61	46	77	77	86	70	62	70	97	100	69	843
1913	69	61	67	46	111	135	180	130	97	125	122	165	1,308

Total number of wells completed in Oklahoma, 1909–1913, by months. [a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	310	288	345	388	374	279	243	239	205	198	200	210	3,279
1910	262	313	325	348	377	378	274	269	306	329	343	253	3,777
1911	290	309	375	479	436	364	313	275	301	275	367	303	4,087
1912	180	366	361	508	501	636	566	526	527	592	654	576	5,993
1913	483	520	492	548	793	885	884	864	775	830	846	931	8,851

[a] Including gas wells.

Initial daily production of new wells completed in Oklahoma in 1913, by districts and months, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total, 1913.	Total, 1912.
Cherokee, deep	5,310	4,955	5,207	6,275	7,270	8,184	5,864	4,718	4,636	3,719	3,687	7,680	67,505	76,025
Cherokee, shallow	1,385	1,050	1,158	2,462	1,484	1,419	1,788	2,138	1,420	1,416	993	959	17,672	10,930
Creek	9,640	10,700	12,307	17,516	15,849	19,828	15,621	18,830	16,456	18,269	17,405	21,375	193,796	77,588
Cleveland	1,625	1,650	1,430	1,435	1,944	1,813	1,328	592	2,264	200	591	915	15,787	33,903
Osage	1,010	1,120	1,388	1,759	573	942	1,466	1,572	2,389	7,192	5,611	9,834	34,856	25,400
Ponca City	250	30	125	400	.....	.....	.....	17	15	22	.....	2,104	2,964	4,790
Carter County	.....	.....	.....	.....	.....	2	.....	15	45	48	480	254	844	.....
Miscellaneous	.....	.....	.....	.....	19	4	4	15	42	86	444	12	626	250
Total	19,220	19,505	21,615	29,847	27,139	32,192	26,071	27,897	27,267	30,953	29,211	43,133	334,050	228,886

Total and average initial daily production of new wells in Oklahoma, 1909–1913, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Cherokee, deep	34,130	28,903	30,135	76,025	67,505	65.8	46.1	37.4	31.1	24.8
Cherokee, shallow	90,864	85,147	70,221	10,930	17,672	59.2	51.1	50.8	14.3	16.5
Creek	68,710	76,485	49,879	77,588	193,796	118.1	116.4	93.1	91.1	80.6
Cleveland	1,865	713	22,100	33,903	15,787	81.1	71.3	171.3	173.0	84.4
Osage	10,205	35,060	89,660	25,400	34,856	136.1	170.2	204.7	60.9	68.9
Ponca City	.....	.....	.....	4,790	2,964	.....	.....	.....	154.5	102.2
Carter County	.....	.....	.....	.....	844	.....	.....	.....	.....	56.3
Miscellaneous	680	330	338	250	626	85.0	14.3	84.5	22.7	21.6
Total	206,454	226,638	262,333	228,886	334,050	75.3	71.1	79.6	48.6	48.0

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Total initial daily production of new wells in Oklahoma, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909.....	21,745	21,820	21,220	20,910	21,020	18,120	16,350	15,480	14,190	11,683	12,225	11,691	206,454	17,205
1910.....	15,840	17,785	20,915	18,932	19,545	26,378	14,915	16,680	18,998	18,585	17,915	20,150	226,638	18,887
1911.....	23,366	23,615	40,539	30,440	28,190	23,970	16,255	12,121	14,709	18,165	17,223	13,740	262,333	21,861
1912.....	9,448	13,807	12,281	17,329	10,993	17,617	18,507	24,635	22,096	27,519	27,599	27,055	228,886	19,074
1913.....	19,220	19,506	21,615	29,847	27,139	32,192	26,071	27,897	27,267	30,963	29,211	43,133	334,050	27,838

GULF OIL FIELD.

GENERAL CONDITIONS.

This field includes the pools of southern Texas and southern Louisiana, because these oils are much alike in their composition and in the products which they yield. In fact, these oils, though occurring over a long stretch of territory, are more uniform in composition than those of the Mid-Continent field. The oil is an asphaltic oil, with some of the characteristics of the oil from Baku, Russia. The similarity of the oil in all the pools of the Gulf field is doubtless due to the fact that it all occurs under practically the same conditions in connection with salt domes, which are thus far peculiar to the Gulf region. This mode of accumulation is somewhat analogous to that of the pools associated with igneous masses near the Gulf coast in Mexico. This Gulf oil has been of great value from the time of its first discovery, serving first an important purpose in developing a cheap and very satisfactory fuel for railroads. It also developed manufacturing enterprises very rapidly in the Gulf region. Later it was found practicable to refine it, and also within recent years the asphalt itself has become valuable for roofing and street paving and the asphaltic oil as a binder in macadam roads. The heavier naphtha serves unusually well as a solvent, and the lubricants have obtained an enviable reputation for their excellence.

PRODUCTION.

This oil field entered into commerce in 1901, and reached its maximum in 1905 with 36,526,323 barrels for that year. Since that time it has declined, at first rapidly, then irregularly, until in 1913 it remained practically constant at 8,542,494 barrels. The price obtained in 1913 was the highest since this petroleum entered the general markets, amounting to $0.936 a barrel. The average price in 1901 was $0.175 a barrel. At the close of 1913 the tendency to drill deeper in connection with the various salt domes of the Gulf field had led to the finding of good gushers approaching in size those of the first days of the field and sufficient in number to increase production so as to reduce the price of crude oil and to indicate a return of the output in previous years. The number of oil wells drilled in the field has been remarkably constant since 1909, averaging slightly over 500 a year. The proportion of dry holes to productive wells was very large in 1913—312 dry holes were completed in that field.

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Production of petroleum in the Gulf field in 1912 and 1913, by months, in barrels.

Month.	1912			1913		
	Coastal Texas.	Coastal Louisiana.	Total.	Coastal Texas.	Coastal Louisiana.	Total.
January	552,107	165,831	717,938	443,707	261,193	704,900
February	555,497	186,345	741,842	423,212	187,491	610,703
March	620,837	163,893	784,730	538,087	338,246	876,333
April	592,677	159,906	752,583	476,895	279,447	756,342
May	552,391	155,375	707,766	509,716	248,051	757,767
June	539,930	144,280	684,210	464,718	231,816	696,534
July	539,020	174,892	713,912	457,051	219,189	676,240
August	519,809	180,835	700,644	472,821	214,699	687,520
September	526,915	148,138	675,053	485,500	198,438	683,939
October	511,058	159,474	670,532	487,849	190,211	678,060
November	472,490	211,851	684,341	492,718	179,071	671,789
December	476,797	234,670	711,467	572,952	169,416	742,368
Total	6,459,528	2,085,490	8,545,018	5,825,226	2,717,268	8,542,494

Production of petroleum in the Gulf field, 1889–1913, in barrels.

Year.	Production.	Percentage of total production.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease. (−)	Value.	Yearly average price per barrel.
1889	48				$340	$7.084
1890	54		+ 6	+ 12.50	229	4.204
1891	54				227	4.204
1892	45		− 9	− 16.67	225	5.000
1893	50		+ 5	+ 11.11	210	4.200
1894	60		+ 10	+ 20.00	300	5.000
1895	50		− 10	− 16.67	250	5.000
1896	50				250	5.000
1897	50				250	5.000
1898	1,450		+ 1,400	+2,800.00	7,250	5.000
1899	530		− 920	− 63.45	2,650	5.000
1900	0		− 530	− 100.00		
1901	3,593,113	5.18	+ 3,593,113		630,752	.175
1902	18,014,404	20.29	+14,421,291	+ 401.36	3,766,683	.209
1903	18,371,383	18.29	+ 356,979	+ 1.98	7,418,393	.411
1904	24,631,269	21.03	+ 6,259,886	+ 34.07	8,817,454	.357
1905	36,526,323	27.11	+11,895,054	+ 48.29	8,791,983	.240
1906	20,524,162	16.23	−16,002,161	− 43.81	9,390,691	.457
1907	16,360,299	9.85	− 4,163,863	− 20.29	13,704,469	.837
1908	15,772,137	8.83	− 588,162	− 3.60	9,511,007	.603
1909	10,883,240	5.94	− 4,888,897	− 30.00	7,872,686	.723
1910	9,680,465	4.62	− 1,202,775	− 11.05	7,383,571	.763
1911	10,999,873	4.99	+ 1,319,408	+ 13.63	7,355,681	.669
1912	8,545,018	3.83	− 2,454,855	− 22.32	6,344,173	.742
1913	8,542,494	3.44	− 2,524	− .03	7,993,997	.936
Total	202,446,620	6.60			98,193,619	.485

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Production, value, and average price per barrel of petroleum produced in the Gulf field, 1904–1913, by years and States, in barrels.

Year.	Coastal Texas.			Coastal Louisiana.			Total.		
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel
1904....	21,672,311	$7,743,860	$0.357	2,958,958	$1,073,594	$0.363	24,631,269	$8,817,454	$0.357
1905....	27,615,907	7,190,658	.2603	8,910,416	1,601,325	.178	36,526,323	8,791,983	.240
1906....	11,449,992	5,825,036	.5087	9,074,170	3,555,655	.392	20,524,162	9,380,691	.457
1907....	11,410,078	9,680,286	.848	4,950,221	4,024,183	.813	16,360,299	13,704,469	.837
1908....	10,483,300	6,221,636	.593	5,288,937	3,289,371	.622	15,772,137	9,511,007	.603
1909....	8,852,927	6,399,318	.723	2,030,713	1,473,368	.725	10,883,240	7,872,686	.723
1910....	7,929,863	6,100,359	.769	1,750,602	1,283,212	.733	9,680,465	7,383,571	.763
1911....	7,275,281	5,340,592	.734	3,724,592	2,015,089	.541	10,999,873	7,355,681	.669
1912....	6,459,528	4,739,887	.734	2,085,490	1,604,286	.769	8,545,018	6,344,173	.742
1913....	5,825,226	5,550,408	.953	2,717,268	2,443,589	.899	8,542,494	7,993,997	.936

Production of petroleum in the Gulf field in 1912 and 1913, by States, showing increase or decrease and percentage of increase or decrease, in barrels.

State.	Production.		Increase.	Decrease.	Percentage.	
	1912	1913			Increase.	Decrease.
Coastal Texas	6,459,528	5,825,226	.....	634,302	.....	9.82
Coastal Louisiana	2,085,490	2,717,268	631,778	.....	30.29	.....
Total	8,545,018	8,542,494	.....	2,524	.....	.03

Production of petroleum in the Gulf oil field, 1909–1913, by months and years, in barrels.

Month.	1909	1910	1911	1912	1913
January	1,095,522	776,908	1,080,926	717,938	704,900
February	982,903	711,583	1,280,144	741,842	610,708
March	1,014,107	790,178	1,283,975	784,730	876,333
April	900,502	746,059	1,004,704	752,583	756,342
May	933,618	771,995	985,075	707,766	757,767
June	873,221	757,875	848,610	684,210	696,534
July	900,630	814,933	822,501	713,912	676,240
August	866,806	844,980	777,506	700,644	687,520
September	816,868	803,947	750,862	675,053	683,938
October	825,307	864,183	758,321	670,532	678,080
November	833,310	847,080	671,778	684,341	671,789
December	840,446	950,744	735,471	711,467	742,368
Total	10,883,240	9,680,465	10,999,873	8,545,018	8,542,494

Average daily production of petroleum in the Gulf oil field each month, 1909–1913, by months and years, in barrels.

Month.	1909	1910	1911	1912	1913
January	35,339	25,062	34,869	23,159	22,739
February	35,104	25,414	45,719	26,581	21,811
March	32,714	25,490	41,419	25,314	28,269
April	30,017	24,869	33,490	25,086	25,211
May	30,117	24,903	31,777	22,831	24,445
June	29,107	25,263	28,287	22,807	23,218
July	29,053	26,288	26,532	23,029	21,814
August	27,961	27,257	25,081	22,601	22,178
September	27,229	26,798	25,029	22,502	22,798
October	26,623	27,877	24,462	21,630	21,873
November	27,777	28,236	22,393	22,811	22,393
December	27,111	30,669	23,725	22,951	23,947
Average	29,817	26,522	30,137	23,347	23,404

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PIPE-LINE RUNS, DELIVERIES, AND STOCKS.

Pipe-line runs and deliveries of petroleum from the Gulf field, by months, in 1913, and stocks at end of each month, in barrels.

Month.	Runs.	Deliveries.	Stocks.
Dec 31, 1912			1,472,247
January	704,900	710,810	1,466,337
February	610,703	588,059	1,488,981
March	876,333	854,248	1,511,066
April	756,342	768,032	1,499,376
May	757,767	723,866	1,533,277
June	696,534	688,463	1,541,348
July	676,240	638,673	1,578,915
August	687,520	719,332	1,546,603
September	663,938	560,705	1,650,336
October	678,060	617,587	1,721,309
November	671,789	556,733	1,836,365
December	742,368	519,957	2,058,776
Total	8,542,494	7,955,965	

PRICES.

The average monthly prices per barrel of petroleum at wells in the Gulf field in the years 1912 and 1913 were as follows:

Average monthly prices per barrel of petroleum in the Gulf field, 1912 and 1913.

1912.

Month.	Coastal Texas.			
	Batson.	Dayton.	Humble.	Saratoga.
January	$0.65–$0.72½	$0.67	$0.65 –$0.72½	$0.65–$0.72½
February	.70– .75	.70	.67½ – .75	.67½ – .75
March	.75	.70	.67 – 675	.67½ – .75
April	.75	.70	.67½ – .75	.67½ – .75
May	.75	.70	.67½ – .75	.67½ – .75
June	.75	.70	.67½ – .75	.67½ – .75
July	.75	.70	.75	.75
August	.75	.70	.75	.75
September	.75	.70	.75	.75
October	.75		.75	.75
November	.75	.70	.75	.75
December	.75	.70	.75	.75
Average	.741	.697	.718	.741

Month.	Coastal Texas.		Coastal Louisiana.	
	Sourlake.	Spindletop.	Jennings.	Vinton.
January	$0.65 –$0.67½	$0.70–$0.80	$0.625–$0.75	$0.500–$0.625
February	.67½– .72	.72– .80	.625– .80	.560– .625
March	.67½– .75	.75– .80	.625– .85	.560– .625
April	.67½– .75	.75– .80	.625– .85	.625– .650
May	.67½– .75	.80	.625– .85	.625– .650
June	.67½– .75	.80	.625– .90	.625– .700
July	.75	.80	.625– .90	.625– .700
August	.75	.80	.625– .90	.625– .700
September	.75	.80	.625– .90	.625– .750
October	.75	.80	.625– .92	.625– .750
November	.75	.80	.625– .92	.625– .750
December	.75	.80	.625– .92	.625– .750
Average	.745	.796	.876	.641

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Average monthly prices per barrel of petroleum in the Gulf field, 1912 and 1913—Contd.

1913.

Month.	Coastal Texas.			
	Batson.	Dayton.	Humble.	Saratoga.
January	$0.75–$0.78	$0.75	$0.87½–$1.00	$0.87½–$1.00
February	.84		1.00	.96 – 1.00
March	.80– .87	.80	.95 – 1.00	.93 – 1.00
April	.80– .90	.80	.90 – 1.00	.90 – 1.00
May	.80– .91	.80	.90 – 1.00	.90 – 1.00
June	.80– .90	.80	.90 – 1.00	.90 – 1.00
July	.80– .94	.80	.90 – 1.00	.90 – 1.00
August	.80– .99	.80	.90 – 1.00	.90 – 1.00
September	.80– .99	.80	.90 – 1.00	.90 – 1.00
October	.80– .99	.80	.90 – 1.00	.90 – 1.00
November	.80– 1.00	.80	.90 – 1.00	.90 – 1.00
December	.80– 1.00	.80	.90 – 1.00	.90 – 1.00
Average	.904	.797	.965	.913

Month.	Coastal Texas.		Coastal Louisiana.	
	Sourlake.	Spindletop.	Jennings.	Vinton.
January	$0.87½–$1.08	$0.84–$0.92½	$0.78–$0.90	$0.73 –$0.90
February	1.00 – 1.08	.98– 1.05	.90– .95	.86 – .90
March	.95 – 1.08	1.00– 1.02	.90– 1.00	.86 – .90
April	.90 – 1.08	.95– 1.06	.90– 1.00	.87 – .90
May	.90 – 1.08	.95– 1.06	.90– 1.00	.87 – .90
June	.90 – 1.08	.95– 1.04	.90– 1.00	.87 – .90
July	.90 – 1.08	.95– 1.04	.90– 1.02	.87½– .90
August	.90 – 1.08	.95– 1.03	.90– 1.00	.87 – .90
September	.90 – 1.08	.95– 1.03	.90– 1.00	.88 – .90
October	.90 – 1.08	.95– 1.04	.90– 1.00	.87 – .90
November	.90 – 1.08	.95– 1.04	.90– 1.00	.87 – .90
December	.90 – 1.06	.95– 1.04	.90– 1.00	.88 – .90
Average	1.000	1.000	.974	.869

WELL RECORD.

Number of wells completed in the Gulf field, 1909–1913, by districts.

District.	Oil.					Dry.					Total completed.[a]				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Coastal Texas	368	365	352	353	325	161	116	117	109	255	538	481	502	462	592
Coastal Louisiana	34	32	63	59	81	28	10	32	25	57	62	42	112	84	139
Total	402	397	415	412	406	189	[a]126	149	134	312	600	523	614	546	731

[a] Including gas wells.

Number of oil wells and dry holes drilled in the Gulf field in 1913, by districts and months.

District.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Coastal Texas	26	6	25	18	32	16	33	30	20	15	31	31	36	27	31	30	25	20	23	21	19	16	24	25	325	255	353	109
Coastal Louisiana	5	3	5	7	11	..	9	15	6	1	9	10	12	6	12	4	4	2	4	1	2	1	2	7	81	57	59	25
Total	31	9	30	25	43	16	42	45	26	16	40	41	48	33	43	34	29	22	27	22	21	17	26	32	406	312	412	134

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Number of oil wells drilled in the Gulf field, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	30	40	36	33	36	24	35	35	30	21	30	18	[a] 402
1910	41	22	43	29	30	26	35	28	25	29	31	26	[a] 397
1911	26	35	29	30	31	58	40	24	19	16	20	24	[a] 415
1912	16	44	39	47	29	30	28	35	34	40	43	27	412
1913	31	30	43	42	26	40	48	43	29	27	21	26	406

[a] Coastal Louisiana not given by months.

Number of dry holes drilled in the Gulf field, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	18	11	18	16	16	11	10	17	15	16	8	14	[a] 198
1910	14	16	9	11	20	11	11	10	7	1	3	3	[a] 126
1911	15	10	17	14	10	17	11	.....	.....	9	9	5	[b] 149
1912	8	9	8	15	14	14	9	12	14	13	8	10	[c] 134
1913	9	25	16	45	16	41	33	34	22	22	17	32	[c] 312

[a] Coastal Louisiana not given by months; including gas wells.
[b] Coastal Louisiana not given by months.
[c] Not including gas wells.

Total number of wells completed in the Gulf field, 1909–1913, by months. [a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	48	51	54	49	52	35	45	52	45	37	38	32	[b] 600
1910	55	38	52	40	50	37	46	38	32	30	34	29	[b] 523
1911	41	46	46	44	41	76	51	41	33	25	29	29	[b] 614
1912	24	53	47	62	43	44	37	47	48	53	51	37	546
1913	42	56	60	90	46	84	81	77	51	49	37	58	731

[a] Including gas wells.
[b] Coastal Louisiana not given by months.

Initial daily production of new wells completed in the Gulf field in 1913, by districts and months, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug	Sept.	Oct.	Nov.	Dec.	Total, 1913.	Total, 1912.
Coastal Texas.....	1,147	3,652	10,936	2,305	5,595	3,195	1,335	1,147	1,757	2,186	1,016	4,707	38,978	33,082
Coastal Louisiana.	14,565	795	16,635	7,995	2,740	2,330	2,940	3,437	330	1,273	50	2,650	55,740	25,520
Total..	15,712	4,447	27,571	10,300	8,335	5,525	4,275	4,584	2,087	3,459	1,066	7,357	94,718	58,602

Total and average initial daily production of new wells in the Gulf field, 1909–1913, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Coastal Texas.....	33,300	63,283	32,740	33,082	38,978	89.7	173.5	93.0	93.7	119.9
Coastal Louisiana...	12,700	15,230	74,145	25,520	55,740	373.5	475.9	1,176.9	432.5	618.1
Total.....	46,000	78,513	106,885	58,602	94,718	114.4	197.8	257.6	142.2	232.3

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Total initial daily production of new wells in the Gulf field, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909.....	2,180	4,160	3,155	2,577	3,090	2,520	4,615	3,285	2,955	1,459	2,334	970	[a]46,000	3,833
1910.....	3,048	3,135	1,150	5,540	2,935	4,457	8,570	3,940	3,500	4,590	13,835	8,583	[a]78,513	6,543
1911.....	5,970	5,800	2,115	6,390	1,561	3,455	2,708	935	1,355	772	619	980	[a]106,885	8,907
1912.....	2,670	5,600	4,679	3,885	2,030	2,575	7,475	3,313	12,045	1,170	7,779	5,291	58,602	4,884
1913.....	15,712	4,447	27,571	10,300	8,335	5,525	4,275	4,584	2,087	3,459	1,066	7,357	94,718	7,893

[a] Coastal Louisiana not given by months.

TEXAS.

DEVELOPMENT.

Two new fields were opened up during the year. One at Moran, Shackelford County, in the northern Texas oil region, and the other in the Gulf region in Orange County.

Electra.—There was considerable extension of the Electra field to the southeast and considerable successful drilling in the neighborhood of Burkburnett in the same county, and also patient prospecting over rather large areas in the old Petrolia region. As a result, the production in the northern Texas field increased very steadily and resulted in a total yield for the State of 15,009,478 barrels, an increase of 3,274,421 barrels over 1912.

Moran.—The existence of natural gas in paying quantities has been known in Shackelford County for years. At the beginning of the year 1913, the Texas Co. was drilling several tests in the neighborhood of Moran, including No. 1 Blackstock, a short distance northeast of Moran, in sec. 56; No. 1 Wild in sec. 65, 1 mile south of Moran; No. 2 Elliott, 2 miles south of Moran; and No. 1 Freeman, about 1 mile south of Moran.

In January, the Texas Co. brought in a gas well yielding 4,000,000 cubic feet in the southwestern part of Throckmorton County, 15 miles north of Albany and at a depth reported as 1,060 feet. This well is located on a lease of some 80,000 acres. Similar leases chiefly controlled by the larger companies characterize the region, which will therefore probably be drilled carefully and with the view to the greatest conservation of the oil and gas. With gas thus found in the neighborhood of Moran and 35 miles to the northwest, a considerable inducement was offered for further wildcatting, although the wells in the neighborhood of Moran required drilling to below 2,000 feet.

The well referred to above as No. 1 Wild, sec. 65, came in making 20 to 30 barrels of oil a day, which quantity gradually increased to 40 and 50 barrels, with the result that all land in this neighborhood was leased with very considerable bonuses. A second well, the No. 1 Edward, yielded 100 to 200 barrels of the light oil (35° B. gravity) characteristic of northern Texas, at a depth of over 2,500 feet. The excitement continued and active drilling in the region extended to Stephens County. At the end of the year it was evident that a new oil field had been developed.

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Orange County.—Seepages of natural gas in the Cow Bayou region of Orange County near the Louisiana line have attracted the attention of drillers for several years, and in January, 1913, the Terry Oil Co. drilled 6 miles west of Terry, Orange County, 2,000 feet; at that depth the well was lost after having shown much natural gas. No. 2 was drilled 400 feet away and by June had begun to show much gas at 800 feet. In the meantime the Rio Bravo Oil Co. acquired a leasehold and, after persistent drilling, obtained a good well of the usual character of the Gulf oil, at a depth of over 3,000 feet. It started at 180 barrels a day and settled to 100 barrels. The considerable depth of the wells rendered drilling slow, but it is evident that a field will eventually be developed.

Sourlake.—At the beginning of March, 1913, the Texas Co.'s well No. 196, about the center of the field, which had been a small producer in the sand at 900 feet, was deepened to 1,200 feet and immediately increased its production to 6,000 barrels a day. This declined to a final yield of 900 barrels at the end of the month. Drilling, of course, became active in all the Gulf pools with such generally successful results as to increase the supply of Gulf oil and to decrease the price of oil.

Toyah.—Drilling was active in the region west of Pecos River in Reeves County three years ago and developed the fact that, although very small wells of thick petroleum can be obtained at a depth of less than 200 feet on the Ross property, some 17 miles west of north of Toyah station, the efforts to secure oil at a greater depth were only successful in one well, in which oil slightly lighter in gravity and containing more sulphur was found by the Producers Oil Co. None of the wells drilled in this region succeeded in getting through the thick beds of gypsum and certainly did not reach the cavernous limestone which outcrops a few miles west of Rustler Springs in Culberson County. During the year 1913, one deep well was drilled near Pedrigan Springs, 9 miles west of Toyah station. The drilling was chiefly in gypsum, but shale is reported in the gypsum at the bottom of the well, and from this shale some oil seeps in. Other deep-drilling tests have encouraged the reexamination of the field by the Producers Oil Co. and others, so that the leasing has been very active, and it is probable that the field will receive a thorough test during 1914. Many of these leases are located on land concerning which the mineral title was in doubt. During the year suit was brought in the Texas Supreme Court against the Texas Land Commissioner by owners of the surface rights in the Toyah region to mandamus the land commissioner to release the minerals to the owner of the surface rights, upon such land as had been patented by the State since the passage of the act of 1907, under which the mineral rights had been reserved to the State on a large portion of the land in West Texas. The position of the State of Texas was sustained as to the reservation of the mineral rights. While this was a disappointment to the holders of surface rights, it has not deterred the investment of both California and eastern capital in lands between the oil seepages in Reeves County and the outcrops of oil-bearing limestone in Culberson County.

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PRODUCTION.

The production of petroleum in Texas from 1904 to 1913, inclusive, has been as follows:

Production of petroleum in Texas, 1904–1913, by districts, in barrels.

Year.	Northern Texas.						Coastal Texas.			
	Corsicana.	Henrietta.	Powell.	Marion County.	Electra.	Total.[a]	Batson.	Dayton.	Goose Creek.	Humble.
1904	374,318	65,455	129,329	.....	.....	569,252	10,904,737	.....	.....	.....
1905	311,554	75,592	132,866	.....	.....	520,282	3,774,841	60,294	.....	15,594,310
1906	332,622	111,072	673,221	.....	.....	1,117,905	2,289,507	92,850	.....	3,571,445
1907	226,311	83,260	596,897	.....	.....	912,618	2,164,453	108,038	.....	2,929,640
1908	211,117	85,963	421,659	.....	.....	723,264	1,593,570	39,901	.....	3,778,521
1909	180,764	113,485	383,137	.....	.....	681,940	1,206,214	17,647	.....	3,237,060
1910	137,331	126,531	450,188	251,717	.....	969,403	1,113,767	9,582	.....	2,495,511
1911	128,526	168,965	373,055	677,689	899,579	2,251,193	1,023,493	4,344	.....	2,426,220
1912	233,282	197,421	251,240	362,870	4,227,104	5,275,579	844,563	12,151	43,898	1,829,923
1913	158,830	344,868	282,476	262,392	8,131,624	9,184,252	741,350	13,329	249,641	1,504,880

Year.	Coastal Texas—Continued.							Total.
	Matagorda County.	Orange County.	Saratoga.	Sourlake.	Spindletop.	Other.	Total.	
1904	151,936	.....	739,239	6,442,357	3,433,842	[b] 50	21,672,161	22,241,413
1905	46,471	.....	3,125,028	3,362,153	1,652,780	[b] 30	27,615,907	28,136,189
1906	3,600	.....	2,182,057	2,156,010	1,077,492	77,031	11,449,992	12,567,897
1907	1,573	.....	2,130,928	2,353,940	1,899,943	21,563	11,410,078	12,322,696
1908	62,640	.....	1,634,786	1,596,060	1,747,537	31,185	10,483,200	11,206,464
1909	29,103	.....	1,183,559	1,703,798	1,388,107	87,039	8,852,527	9,534,467
1910	455,999	.....	1,024,348	1,518,723	1,182,436	129,497	7,929,863	8,899,266
1911	561,828	.....	925,777	1,364,880	965,939	2,800	7,275,281	9,526,474
1912	613,292	.....	1,116,655	1,175,108	822,916	1,022	6,459,528	11,735,057
1913	294,553	17,706	937,720	1,348,053	716,374	1,620	5,825,226	15,009,478

[a] Includes other districts of northern Texas. [b] Bexar County.

Production and value of petroleum in northern and coastal Texas, 1904–1913, in barrels.

Year.	Northern Texas.		Coastal Texas.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	569,102	$412,360	21,672,311	$7,743,860	22,241,413	$8,152,220
1905	520,282	361,604	27,615,907	7,190,658	28,136,187	7,552,262
1906	1,117,905	740,542	11,449,992	5,825,036	12,567,897	6,565,578
1907	912,618	721,577	11,410,078	9,680,286	12,322,696	10,401,863
1908	723,264	479,072	10,483,200	6,221,636	11,206,464	6,700,708
1909	681,940	393,732	8,852,527	6,309,318	9,534,467	6,793,050
1910	969,403	505,396	7,929,863	6,100,359	8,899,266	6,605,755
1911	2,251,193	1,213,960	7,275,281	5,340,592	9,526,474	6,554,552
1912	5,275,529	4,112,826	6,459,528	4,739,887	11,735,057	8,852,713
1913	9,184,252	9,125,185	5,825,226	5,550,408	15,009,478	14,675,593

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The following table gives a statement of the production and value of petroleum at wells in Texas in 1912 and 1913, by districts:

Production and value of petroleum in Texas in 1912 and 1913, by districts, in barrels, with increase or decrease, in barrels, and percentage of increase or decrease.

	1912			1913			Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.		
Northern Texas:								
Corsicana	233,282	$149,393	$0.640	158,830	$156,844	$0.987	− 74,452	− 31.92
Henrietta	197,421	134,681	.682	344,868	342,783	.994	+ 147,447	+ 74.69
Powell	251,240	193,439	.769	282,476	216,402	.766	+ 31,236	+ 12.43
Electra	4,227,104	3,340,828	.790	8,131,624	8,142,797	1.001	+3,904,520	+ 92.37
Marion County	362,870	290,974	.802	262,392	261,965	.998	− 100,478	− 27.69
Other	3,612	3,511	.972	4,062	4,394	1.081	+ 450	+ 12.40
Total	5,275,529	4,112,826	.779	9,184,252	9,125,185	.994	+3,908,723	+ 74.08
Coastal Texas:								
Batson	844,563	625,812	.741	741,350	670,323	.904	− 103,213	− 12.22
Dayton	12,151	8,473	.697	13,329	10,633	.797	+ 1,178	+ 9.69
Goose Creek	43,898	27,791	.633	249,641	206,311	.826	+ 205,743	+468.68
Humble	1,829,923	1,313,229	.718	1,504,880	1,453,158	.965	− 325,043	− 17.76
Matagorda County	613,292	406,032	.662	294,553	266,338	.904	− 318,739	− 51.97
Orange County	.....	.....	.....	17,706	19,123	1.080	+ 17,706	.....
Saratoga	1,116,655	827,847	.741	937,720	855,935	.913	− 178,935	− 16.02
Sourlake	1,175,108	874,897	.745	1,348,053	1,350,379	1.000	+ 172,945	+ 14.72
Spindletop	822,916	654,778	.796	716,374	716,993	1.000	− 106,542	− 12.95
Other	1,022	1,028	1.000	1,620	1,215	.75	+ 598	+ 58.51
Total	6,459,528	4,739,887	.934	5,825,226	5,550,408	.953	− 634,302	− 9.82
Total Texas.	11,735,057	8,852,713	.754	15,009,478	14,675,593	.978	+3,274,421	+ 27.90

In the following table will be found the production of petroleum in Texas, by districts and months, for the years 1912 and 1913:

Production of petroleum in Texas, 1912–1913, by districts and months, in barrels.

1913.

Month.	Northern Texas.							Coastal Texas.
	Corsicana.	Henrietta.	Powell.	Electra.	Marion County.	Other.[a]	Total.	Batson.
January	16,473	12,758	21,826	225,264	35,724	274	312,319	77,397
February	30,088	12,213	20,770	206,340	34,685	301	304,397	69,976
March	22,277	13,999	21,393	290,415	35,580	302	383,966	78,339
April	24,040	14,275	21,713	300,154	33,839	306	394,327	76,696
May	20,309	16,689	21,892	377,143	33,467	302	469,802	71,527
June	17,545	16,929	20,146	342,186	30,859	302	427,967	73,095
July	20,944	16,210	22,584	369,575	29,084	304	458,701	66,654
August	17,652	15,840	19,944	373,123	27,660	305	454,533	70,107
September	16,143	18,157	19,991	384,807	25,639	302	465,039	67,929
October	17,034	21,679	20,306	450,549	26,046	305	535,919	68,409
November	15,286	18,362	19,876	450,856	25,098	305	529,783	62,671
December	15,491	20,310	20,799	456,692	25,180	304	538,776	61,764
Total	233,282	197,421	251,240	4,227,104	362,870	3,612	5,275,529	844,563

[a] Includes small production in South Bosque, and Brown, McCulloch, and McMullen counties.

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Production of petroleum in Texas, 1912–1913, by districts and months, in barrels—Con.

1912—Continued.

Month.	Coastal Texas.							Total.
	Humble.	Matagorda County.	Saratoga.	Sour-lake.	Spindle-top.	Other.[a]	Total.	
January	180,417	32,393	88,474	107,228	61,176	5,022	552,107	864,426
February	164,522	68,813	90,019	95,330	61,939	4,898	555,497	859,804
March	186,815	89,844	92,735	104,015	64,029	5,060	620,837	1,004,803
April	166,953	80,890	85,886	102,972	74,861	4,420	592,677	987,004
May	174,039	52,862	87,067	98,812	63,420	4,664	552,391	1,022,193
June	156,489	59,212	87,628	90,352	68,212	4,942	539,930	967,897
July	168,763	48,948	80,163	99,949	70,004	4,539	539,020	997,721
August	147,353	40,446	94,133	96,481	66,317	4,972	519,809	974,342
September	132,775	37,663	118,046	96,650	68,921	4,931	526,915	991,954
October	122,828	38,057	109,382	96,087	72,431	3,864	511,058	1,046,977
November	115,014	30,868	92,093	92,060	74,127	5,657	472,490	1,002,273
December	113,955	33,296	91,029	95,172	77,479	4,102	476,797	1,015,573
Total	1,829,923	613,292	1,116,655	1,175,108	822,916	57,071	6,459,528	11,735,057

[a] Includes Dayton, Goose Creek, and Duval and Brewster counties.

1913.

Month.	Northern Texas.							Coastal Texas.	
	Corsicana.	Henrietta.	Powell.	Electra.	Marion County.	Other.[a]	Total.	Batson.	Goose Creek.
January	13,889	21,479	22,649	482,240	23,035	337	563,629	58,910	17,655
February	13,288	20,305	21,763	460,133	21,954	337	537,780	56,856	14,184
March	14,662	30,059	23,409	535,524	22,651	337	626,642	62,157	15,857
April	14,243	27,693	23,797	557,094	23,794	337	646,958	61,136	16,341
May	13,779	32,626	24,156	613,602	22,808	337	707,308	64,101	27,341
June	16,788	28,187	23,791	682,831	22,570	342	774,509	59,889	23,275
July	12,873	30,027	24,415	759,961	21,095	343	848,714	60,370	20,120
August	12,942	30,660	23,868	771,300	24,050	337	863,157	67,842	22,832
September	11,707	34,428	24,336	796,213	20,302	338	887,324	64,575	21,987
October	15,185	32,424	23,692	844,934	19,864	339	936,438	59,565	23,592
November	9,119	29,108	25,019	820,887	21,456	339	905,928	64,343	24,084
December	10,355	27,872	21,581	806,905	18,813	339	885,865	61,606	22,373
Total	158,830	344,868	282,476	8,131,624	262,392	4,062	9,184,252	741,350	249,641

Month.	Coastal Texas.							Total.
	Humble.	Matagorda County.[b]	Orange County.	Saratoga.	Sour-lake.	Spindle-top.	Other.[c]	Total.	
January	109,033	32,489	.....	83,260	69,207	72,623	530	443,707	1,007,336
February	100,245	27,004	.....	72,611	86,503	65,674	135	423,212	960,992
March	112,188	30,142	.....	80,724	165,667	70,669	683	538,087	1,164,729
April	114,376	30,334	.....	79,582	107,113	66,847	1,166	476,895	1,123,853
May	110,053	30,085	.....	83,124	130,661	63,123	1,228	509,716	1,217,024
June	119,628	24,594	.....	78,324	100,079	58,483	446	464,718	1,239,227
July	115,553	23,526	.....	79,914	97,125	59,976	467	457,051	1,305,765
August	120,080	21,478	1,848	79,633	101,322	56,685	1,101	472,821	1,335,978
September	133,172	20,984	3,013	76,768	115,488	46,297	3,216	485,500	1,372,824
October	135,214	18,766	2,578	78,547	116,143	51,196	2,248	487,849	1,424,281
November	136,405	17,572	6,694	73,851	116,350	51,773	1,646	492,718	1,398,646
December	196,933	17,579	3,573	71,382	142,395	53,028	2,083	572,925	1,458,817
Total	1,504,880	294,553	17,706	937,720	1,348,053	716,374	14,949	5,825,226	15,009,478

[a] Includes Archer, Coleman, Brown, McCulloch, and McLennan counties.
[b] Markham and Big Hill.
[c] Includes Duval County and Dayton.

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RAILROAD SHIPMENTS.

In the following table is given the shipments of petroleum by railroad in tank cars from the different stations of Texas during the years 1912 and 1913:

Quantity of petroleum shipped by railroad in tank cars from the oil fields of Texas, at the stations named, by months, during the years 1912 and 1913, in barrels.

1912.

Month.	Electra.	Beaumont, Guffey.	Corsicana.	Danbury, Markham, Christine, Noledo.	Houston (Trice).	Humble.	Saratoga.	Sourlake.	Petrolia.	Total.
January	35,712	158,269	4,905	12,206	129,446	109,715	1,396	9,440	7,345	468,434
February	24,324	95,118	4,905	22,940	107,094	51,579	450	15,358	8,540	330,308
March	59,464	113,527	4,905	24,309	71,185	60,943	1,673	7,880	9,049	352,985
April	35,560	109,308	4,905	27,880	50,072	60,356	450	18,941	3,938	311,390
May	98,265	136,840	4,905	16,792	61,616	50,737	450	32,191	3,105	404,901
June	35,063	122,149	4,905	29,095	90,889	53,337	.....	29,854	300	365,592
July	21,959	105,453	4,905	17,360	118,665	54,635	676	23,239	.....	346,892
August	14,439	101,445	4,906	10,680	111,970	60,333	1,351	.....	.....	305,124
September	17,164	69,808	4,906	13,928	115,122	45,744	2,252	8,305	.....	227,229
October	18,570	130,320	4,906	12,384	104,225	50,156	1,126	15,212	.....	336,899
November	13,115	57,840	4,906	7,588	85,200	44,385	1,802	71,007	.....	285,843
December	19,029	59,513	4,906	8,480	82,323	18,300	1,808	110,090	.....	304,449
Total	392,664	1,259,590	58,865	203,622	1,127,807	660,220	13,434	341,467	32,277	4,089,946

1913.

Month.	Electra, Iowa Park, Petrolia.	Beaumont, Guffey.	Corsicana.[a]	Markham, Noledo.	Houston (Trice).	Humble.	Saratoga.	Sourlake.	Total.
January	18,706	46,527	6,962	4,420	44,263	16,735	1,834	10,587	150,034
February	32,748	70,830	6,962	5,571	10,143	45,155	450	19,540	191,399
March	24,436	14,748	6,962	3,095	10,100	24,585	225	12,638	96,789
April	42,708	22,348	6,962	4,670	10,479	22,722	679	23,398	133,966
May	57,919	19,557	6,962	8,048	19,545	24,821	1,350	77,144	215,346
June	40,602	43,141	6,962	11,122	22,420	17,608	.....	29,720	171,575
July	31,601	10,476	6,962	6,810	44,327	19,221	.....	32,740	152,137
August	27,352	7,349	6,962	5,571	71,358	11,307	.....	15,240	145,139
September	36,181	5,594	6,963	4,454	58,094	7,135	.....	31,327	149,748
October	57,302	27,729	6,963	6,345	44,256	7,461	.....	22,771	172,827
November	99,071	20,916	6,963	4,952	50,464	8,779	1,125	29,863	222,133
December	84,299	36,576	6,963	3,250	56,982	8,323	.....	5,977	202,370
Total	552,925	325,791	83,548	68,308	442,431	213,852	5,663	310,945	2,003,463

[a] Averaged.

WELL RECORD.

Drilling was unusually active in 50 counties of Texas. In all 1,391 wells were drilled, 592 in the Gulf region and 799 in northern Texas. In the Electra field, 311 oil wells were obtained and only 63 dry holes; at Burkburnett 89 wells were drilled, 24 of which were dry. In Clay County, out of 171 wells 45 were dry. Outside of Wichita, Clay, Navarro, and Marion Counties, drilling in northern Texas was practically all of the wildcat order, that is, of the 166 wells drilled, 156 were dry and only 5 oil wells and 5 gas wells were obtained. In northern Texas this wildcatting was carried on in the following counties: Archer, Baylor, Brown, Callahan, Coleman, Hall, Jack, McCulloch, Shackelford, Stephens, Throckmorton, Titus, Wilbarger, Wilson,

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Wise, and Young. In coastal Texas, drilling was also very active, and fairly satisfactory results were obtained in the old fields; but from 62 wells drilled in wildcat territory only 5 oil wells and 5 gas wells were obtained. Besides various attempts at wildcatting in other regions, wells were actually completed in the following counties of coastal Texas: Angelina, Atascosa, Bee, Bexar, Brazoria, Brazos, Brown, Chambers, Comanche, Eastland, Erath, Franklin, Freestone, Gonzales, Hardin, Harris, Houston, Jefferson, Liberty, Limestone, Madison, Matagorda, Montgomery, Orange, Polk, Sabine, Shelby, Tyler, and Willacy.

WELL RECORD IN NORTHERN TEXAS.

The following tables give the well record in northern Texas from 1909 to 1913, inclusive:

Number of wells completed in northern Texas, 1909–1913, by districts.

District.	Oil.					Dry.					Total completed.[a]				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Corsicana	4	17	20	17	3	1	10	19	7	1	5	27	39	24	4
Electra	.....	.....	51	259	[b]435	.....	.....	1	66	[b]125	.....	.....	53	326	[b]561
Henrietta	20	35	7	6	122	15	37	9	10	45	46	72	19	20	171
Marion County	.....	.....	6	3	16	.....	.....	9	7	6	.....	.....	15	10	22
Powell	87	56	.....	.....	.....	28	35	.....	.....	.....	118	91	.....	.....	.....
South Bosque	1	.....	.....	.....	.....	1	.....	.....	.....	.....	2	.....	.....	.....	.....
Other	4	.....	.....	14	5	.....	.....	.....	34	31	4	.....	.....	54	41
Total	116	108	84	299	581	45	[a]82	38	124	208	175	190	126	434	799
Coastal Texas	368	365	352	353	325	161	116	117	109	255	538	481	502	462	592
Total Texas	484	473	436	652	906	206	198	155	233	463	713	671	628	896	1,391

[a] Including gas wells. [b] Including other districts in Wichita County.

Number of oil wells and dry holes drilled in northern Texas in 1913, by districts and months.

District.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Corsicana	3	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3	1	17	7
Electra [a]	29	16	23	17	22	6	28	7	33	8	30	8	30	9	47	7	41	9	44	9	65	22	43	7	435	125	259	66
Henrietta	5	1	8	5	11	5	25	6	24	7	21	7	15	6	8	5	...	...	3	..	1	1	1	2	122	45	6	10
Marion County	...	...	...	...	1	...	...	...	...	...	10	2	2	..	1	1	...	...	1	1	1	1	...	1	16	6	3	7
Other	1	9	...	3	1	1	2	3	...	3	...	2	...	2	...	7	...	...	...	...	1	1	...	...	5	31	14	34
Total	38	27	31	25	35	12	55	16	57	18	61	19	47	17	56	20	41	9	48	10	68	25	44	10	581	208	299	124
Coastal Texas	26	6	25	18	32	16	33	30	20	15	31	31	36	27	31	30	25	20	23	21	19	16	24	25	325	255	353	109
Total Texas	64	33	56	43	67	28	88	46	77	33	92	50	83	44	87	50	66	29	71	31	87	41	68	35	906	463	652	233

[a] Includes in 1913 other districts in Wichita County.

Number of oil wells drilled in northern Texas, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	.....	2	.....	4	18	15	17	7	12	10	20	6	[a]116
1910	[b]	20	13	20	10	12	8	6	11	2	5	1	108
1911	2	7	4	13	1	.....	7	3	9	7	12	19	84
1912	4	21	22	33	38	12	20	34	22	44	22	27	299
1913	38	31	35	55	57	61	47	56	41	48	68	44	581

[a] South Bosque not reported by months. [b] No record.

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Number of dry holes drilled in northern Texas, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	6	2	.....	4	4	5	4	4	7	4	11	7	[b] 59
1910	(a)	6	6	9	5	8	14	6	10	6	7	5	[b] 82
1911	7	8	5	8	2	.....	2	3	.....	.....	1	2	[c] 38
1912	.....	3	8	8	11	19	12	18	8	10	19	8	[c] 124
1913	27	25	12	16	18	19	17	20	9	10	25	10	[c] 208

[a] No record. [b] Including gas wells. [c] Not including gas wells.

Total number of wells completed in northern Texas, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	6	4	.....	8	22	20	21	11	19	14	31	13	[a] 175
1910	(b)	26	19	29	15	20	22	12	21	8	12	6	190
1911	9	15	10	22	3	.....	10	6	9	7	14	21	126
1912	4	24	31	44	49	31	32	53	32	55	42	37	434
1913	66	57	47	73	76	80	66	77	50	59	93	55	799

[a] South Bosque not reported by months. [b] No record.

Initial daily production of new wells completed in northern Texas in 1913, by districts and months, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total, 1913.	Total, 1912.
Corsicana	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	108
Electra [a]	2,662	3,076	2,702	1,800	5,585	5,428	6,282	4,482	5,605	4,740	4,436	2,488	49,286	26,932
Henrietta	47	290	252	105	673	122	349	26	.....	302	500	10	2,676	315
Marion County	.....	.....	30	.....	.....	4,170	760	85	.....	50	155	.....	5,250	198
Other	5	.....	2	4	.....	.....	.....	.....	.....	.....	200	.....	211	660
Total	2,726	3,366	2,986	1,909	6,258	9,720	7,391	4,593	5,605	5,092	5,291	2,498	57,435	28,213
Coastal Texas	1,147	3,652	10,936	2,305	5,595	3,195	1,335	1,147	1,757	2,186	1,016	4,707	38,978	33,082
Total Texas	3,873	7,018	13,922	4,214	11,853	12,915	8,726	5,740	7,362	7,278	6,307	7,205	96,413	61,295

[a] Includes in 1913 other districts in Wichita County.

Total and average initial daily production of new wells in northern Texas, 1909–1913, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Corsicana	25	54	107	108	12	6.2	3.2	5.4	6.4	4.0
Electra	.....	.....	15,550	26,932	[a]49,286	.....	.....	304.9	104.0	113.3
Henrietta	484	1,331	69	315	2,676	24.2	38.0	9.9	52.5	21.9
Marion County	.....	.....	3,454	198	5,250	.....	.....	575.7	66.0	328.1
Powell	668	298	.....	.....	.....	7.8	5.3	.....	.....	.....
Other	.....	.....	.....	660	211	.....	.....	.....	47.1	42.2
Total	1,177	1,683	19,180	28,213	57,435	10.8	15.6	228.3	94.3	98.9
Coastal Texas	33,300	63,283	32,740	33,082	38,978	89.7	173.5	93.0	93.7	119.9
Total Texas	34,477	64,966	51,920	61,295	96,413	71.2	137.3	119.1	94.0	106.4

[a] Includes other districts in Wichita County.

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Total initial daily production of new wells in northern Texas, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909	0	50	0	45	117	133	227	73	74	154	248	56	1,177	98
1910	(a)	210	77	83	43	1,044	54	26	50	9	62	25	1,683	140
1911	4	3,265	12	567	200	.....	428	450	2,300	2,209	5,250	4,495	19,180	1,598
1912	650	3,395	3,185	2,004	2,955	955	1,909	2,462	2,250	5,006	1,678	1,764	28,213	2,351
1913	2,726	3,366	2,986	1,909	6,258	9,720	7,391	4,593	5,605	5,092	5,291	2,498	57,435	4,786

a No record.

WELL RECORD IN COASTAL TEXAS.

The following tables give the well record in coastal Texas from 1909 to 1913, inclusive:

Number of wells completed in coastal Texas, 1909–1913, by districts.

District.	Oil.					Dry.					Total completed.a				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Batson	40	51	23	23	51	11	14	10	7	16	51	65	36	30	69
Dayton	0	.....	.....	.....	.....	4	.....	.....	.....	.....	4	.....	.....	.....	.....
Goose Creek	5	1	1	17	27	2	2	4	9	24	7	3	5	26	51
Hoskins Mound b	1	2	.....	.....	.....	1	2	.....	.....	.....	2	4	.....	.....	.....
Humble	129	115	122	90	89	64	45	40	27	54	201	160	170	117	144
Markham	2	9	27	31	8	.....	7	9	17	13	2	16	41	48	21
Piedras Pintas	2	1	.....	.....	.....	10	.....	.....	.....	.....	12	1	.....	.....	.....
Saratoga	27	30	45	91	49	4	7	10	11	28	31	37	56	102	78
Sourlake	116	83	76	54	64	29	12	21	8	18	146	95	101	62	85
Spindletop	46	73	58	47	29	36	27	23	30	40	82	100	93	77	69
Miscellaneous	.....	.....	.....	.....	8	.....	.....	.....	.....	62	.....	.....	.....	.....	75
Total	368	365	352	353	325	161	116	117	109	255	538	481	502	462	592
Northern Texas	116	108	84	299	581	45	a82	38	124	208	175	190	126	434	799
Total Texas	484	473	436	652	906	206	198	155	233	463	713	671	628	896	1,391

a Including gas wells. b Includes West Columbia.

Number of oil wells and dry holes drilled in coastal Texas in 1913, by districts and months

District.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Batson	3	1	3	1	4	..	6	..	1	..	4	1	7	3	4	3	7	..	5	5	5	1	2	1	51	16	23	7
Goose Creek	2	..	4	..	2	4	..	2	4	1	1	2	4	1	1	7	1	3	3	3	1	1	4	..	27	24	17	9
Humble	3	1	4	2	6	4	9	2	5	2	9	4	17	4	7	9	6	12	5	3	6	6	12	5	89	54	90	27
Markham	..	..	1	..	1	..	5	1	..	2	..	2	..	2	..	1	1	..	..	2	..	3	..	..	8	13	31	17
Saratoga	9	4	6	2	10	4	4	9	6	..	5	6	1	1	6	1	1	1	1	..	..	..	..	..	49	28	91	11
Sourlake	4	..	2	1	6	1	7	2	2	1	10	1	2	5	6	2	7	1	7	1	5	..	6	3	64	18	54	8
Spindletop	5	..	5	3	3	1	2	5	2	6	2	12	2	5	3	4	1	2	2	..	2	1	..	1	29	40	47	30
Miscellaneous	..	..	..	9	..	2	..	9	..	3	..	3	3	6	4	3	1	1	..	7	..	4	..	15	8	62	..	..
Total	26	6	25	18	32	16	33	30	20	15	31	31	36	27	31	30	25	20	23	21	19	16	24	25	325	255	353	109
Northern Texas	38	27	31	25	35	12	55	16	57	18	61	19	47	17	56	20	41	9	48	10	68	25	44	10	581	208	299	124
Total Texas	64	33	56	43	67	28	88	46	77	33	92	50	83	44	87	50	66	29	71	31	87	41	68	35	906	463	652	233

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Number of oil wells drilled in coastal Texas, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	30	40	36	33	36	24	35	35	30	21	30	18	368
1910	41	22	43	29	30	26	35	28	25	29	31	26	365
1911	26	35	29	30	31	58	40	24	19	16	20	24	352
1912	13	41	35	45	24	25	23	30	27	38	34	18	353
1913	26	25	32	33	20	31	36	31	25	23	19	24	325

Number of dry holes drilled in coastal Texas, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	18	11	18	16	16	11	10	17	15	16	8	14	[a] 170
1910	14	16	9	11	20	11	11	10	7	1	3	3	[a] 116
1911	15	10	17	14	10	17	11	.....	.....	9	9	5	[b] 117
1912	8	8	8	13	13	10	8	9	10	8	5	9	[b] 109
1913	6	18	16	30	15	31	27	30	20	21	16	25	[b] 255

[a] Including gas wells. [b] Not including gas wells.

Total number of wells completed in coastal Texas, 1909–1913, by months. [a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	48	51	54	49	52	35	45	52	45	37	38	32	538
1910	55	38	52	40	50	37	46	38	32	30	34	29	481
1911	41	46	46	44	41	76	51	41	33	25	29	29	502
1912	21	49	43	58	37	35	31	39	37	46	39	27	462
1913	34	43	49	66	38	65	63	61	45	44	35	49	592

[a] Including gas wells.

Initial daily production of new wells completed in coastal Texas in 1913, by districts and months, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total, 1913.	Total, 1912.
Batson	85	165	188	100	3,000	1,620	270	227	157	78	53	37	5,980	829
Goose Creek	145	140	950	.....	935	20	350	50	60	220	100	160	3,130	3,005
Humble	32	72	275	415	1,340	225	535	290	205	775	280	3,675	8,119	5,615
Markham	.....	45	90	230	.....	.....	.....	.....	15	.....	.....	.....	380	10,040
Saratoga	295	2,895	2,873	1,160	110	345	25	150	15	15	.....	.....	7,883	9,350
Sourlake	145	60	6,225	235	50	935	20	160	1,285	1,080	413	835	11,443	1,530
Spindletop	445	275	335	165	160	50	85	60	15	18	170	.....	1,778	2,713
Miscellaneous	.....	.....	.....	.....	.....	.....	50	210	5	.....	.....	.....	265	.....
Total	1,147	3,652	10,936	2,305	5,595	3,195	1,335	1,147	1,757	2,186	1,016	4,707	38,978	33,082
Northern Texas	2,726	3,366	2,986	1,909	6,258	9,720	7,391	4,593	5,605	5,092	5,291	2,498	57,435	28,213
Total Texa	3,873	7,018	13,922	4,214	11,853	12,915	8,726	5,740	7,362	7,278	6,307	7,205	96,413	61,295

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Total and average initial daily production of new wells in coastal Texas, 1909–1913, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Batson	2,179	2,328	606	829	5,980	54.0	45.6	26.3	36.0	117.3
Goose Creek	54	100	250	3,005	3,130	11.0	100.0	250.0	176.8	115.9
Hoskins Mound	20	4,500	.....	.....	.....	20.0	2,250.0	.....	.....	.....
Humble	8,645	7,502	4,597	5,615	8,119	67.0	65.2	37.6	62.3	91.2
Markham	175	22,100	13,275	10,040	380	87.0	2,455.5	491.7	323.8	47.5
Piedras Pintas	175	150	.....	.....	.....	87.0	150.0	.....	.....	.....
Saratoga	3,590	2,137	2,309	9,350	7,883	13.3	71.2	51.3	102.7	160.9
Sourlake	12,737	16,388	4,463	1,530	11,443	11.0	197.4	58.7	28.3	178.8
Spindletop	5,725	8,078	7,240	2,713	1,778	12.4	110.7	124.8	57.7	61.3
Miscellaneous	.....	.....	.....	.....	265	.....	.....	.....	.....	33.1
Total	33,300	63,283	32,740	33,082	38,978	89.7	173.5	93.0	93.7	119.9
Northern Texas	1,177	1,683	19,180	28,213	57,435	10.8	15.6	228.3	94.3	98.9
Total Texas	34,477	64,966	51,920	61,295	96,413	71.2	137.3	119.1	94.0	106.4

Total initial daily production of new wells in coastal Texas, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909	2,180	4,160	3,155	2,577	3,090	2,520	4,615	3,285	2,955	1,459	2,334	970	33,300	2,775
1910	3,048	3,135	1,150	5,540	2,935	4,457	8,570	3,940	3,500	4,590	13,835	8,583	63,283	5,274
1911	5,970	5,890	2,115	6,380	1,561	3,455	2,708	935	1,353	772	619	980	32,740	2,728
1912	935	5,495	3,359	3,435	875	1,805	5,265	2,038	6,055	1,080	1,259	1,481	33,082	2,757
1913	1,147	3,652	10,936	2,305	5,595	3,195	1,335	1,147	1,757	2,186	1,016	4,707	38,978	3,248

LOUISIANA.

DEVELOPMENT.

Caddo.—The development in the Caddo field continued in the characteristically erratic manner during 1913 and resulted in a very great output from perhaps a larger number of gushers yielding 1,000 barrels or more each than had been the case in 1912. The following table gives the list of the principal gushers developed in the field during 1913:

Principal wells developed in Caddo field, La., in 1913

Date.	Location.	Owner.	Capacity.	Depth.
			Barrels.	*Feet.*
Apr. 17	No. 1, sec. 19, T. 20, R. 15	South Western Gas & Electric Co.	1,800	.....
May 8	No. 1, Stoakley	Phœnix Oil Co	3,500	.....
May 16	No. 1, Noel, Mooringsport	Atlas Oil Co	3,000	.....
May 22	At Mooringsport	Azel Ford Co	1,300	.....
May 29	No. 96, W. P. Stiles, sec. 28, T. 21, R. 16, Trees city.	Standard Oil Co. of La	18,000	.....
29	No. 3, Pitts, sec. 19, T. 20, R. 15	Producers Oil Co	8,000	.....
July 17	No. 1, sec. 21, T. 20, R. 15	Gulf Refining Co	1,800	2,239
17	No. 4, Brown lease, sec. 19, T. 20, R. 15	Producers Oil Co	3,000	.....
July 24	Sec. 19, T. 20, R. 15	Higgins Oil Co	7,000	.....
Aug. 21	Leonard lease, Caddo city, sec. 35, T. 21, R. 16	Richardson Oil Co	3,000	.....
Aug. 28	Loucks	Star Oil Co	4,700	.....
Sept. 25	106 Stiles, sec. 21, T. 21, R. 16	Standard Oil Co. of La	1,800	.....
Oct. 23	No. 1, Stiles, sec. 15, T. 21, R. 16	Gulf Refining Co	6,000	.....

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The year 1913 was characterized by some of the most disastrous fires that have ever been known in the oil industry. The phenomenal success in extinguishing them has added much to the ability to control such catastrophes in the future.

De Soto Parish.—A feature of great importance to the State was the development near Mansfield in De Soto Parish. On May 10, 1913, the Gulf Refining Co.'s well No. 2 on the Jenkins lease, 1 mile northeast of Naborton, De Soto Parish, came in unexpectedly at a depth of about 2,400 feet. At first the well showed chiefly gas, but by the next day it began yielding oil and was closed in pending the erection of proper storage. At first the well flowed at the rate of over 1,000 barrels a day, and then settled down to 500 barrels. Sufficient interest had been aroused by the discovery of oil in small quantities with the shallow gas near Mansfield to maintain considerable wildcatting in all directions; a well 8 miles southeast of Naborton had attracted some attention from the showings of oil; the Gulf Co. had drilled Jenkins No. 1, 5 miles east of Mansfield; but the drilling of Jenkins No. 2 made it evident that a valuable oil sand had been found. Hence even before the well was tested the excitement to get leases was unusually great, and conditions were complicated by the fact that many leases had been allowed to lapse.

As soon as the Jenkins No. 2 was drilled a 6-inch pipe line was laid to a loading rack at the railroad at Mansfield. The oil is similar to Caddo crude. By August drilling by all the large companies interested in northern Louisiana was very active. In October the eccentricity of this field was shown by the finding of a gas well of great volume—40,000,000 to 60,000,000 cubic feet a day—with very high pressure at the unusually great depth of 2,800 feet. By the end of the year several good oil producers had been developed with the prospect of considerable extension of the field. The oil-bearing sand is found at from 2,400 to 2,900 feet.

The excitement caused by these developments was tempered by the appearance of water from a sand below, but the efforts to bring in further wells continued with more careful and conservative drilling methods. Just about the close of the year a series of good wells were drilling 6 miles northeast of the De Soto pool proper, and had it not been for the heavy rains which delayed drilling, the production would have increased still more. These developments have sufficed to cause leasing even in remote parts of the State and also an unusual amount of wildcatting.

PRODUCTION.

Production of petroleum in Louisiana, 1904–1913, by districts, in barrels.

Year.	Coastal Louisiana.				Caddo.	Total.
	Jennings.	Welsh.	Anse la Butte.	Vinton.		
1904	2,923,066	35,892				2,958,958
1905	8,891,416	10,000	9,000			8,910,416
1906	9,025,174	23,996	25,000		3,358	9,077,528
1907	4,842,520	47,316	60,385		50,000	5,000,221
1908	5,111,577	31,555	145,805		499,937	5,788,874
1909	1,966,614	26,169	37,930		1,028,818	3,059,531
1910	1,625,159	54,724	44,018	26,701	5,090,793	6,841,395
1911	1,180,177	27,901	62,411	2,454,103	6,995,828	10,720,420
1912	1,105,711	22,140	25,000	932,639	7,177,949	9,263,439
1913	790,648	31,144	6,612	1,888,864	9,781,560	12,498,828

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The following table shows the production of petroleum in Louisiana in 1912 and 1913, by districts and months:

Production of petroleum in Louisiana in 1912 and 1913, by districts and months, in barrels.

1912.

Month.	Jennings.	Welsh.	Anse la Butte.	Caddo.	Vinton.	Total.
January	89,226	1,845	1,700	550,691	73,060	716,522
February	117,952	1,845	2,109	646,488	64,439	832,833
March	94,049	1,845	2,119	583,518	65,880	747,411
April	97,033	1,845	2,119	700,594	58,909	860,500
May	80,738	1,845	2,119	648,826	70,673	804,201
June	87,809	1,845	2,119	617,267	52,507	761,547
July	102,816	1,845	2,119	592,223	68,112	767,115
August	101,254	1,845	2,119	583,805	75,617	764,640
September	85,510	1,845	2,119	593,422	58,664	741,560
October	84,102	1,845	2,119	562,616	71,408	722,090
November	83,449	1,845	2,119	550,887	124,438	762,738
December	81,773	1,845	2,120	547,612	148,932	782,282
Total	1,105,711	22,140	25,000	7,177,949	932,639	9,263,439

1913.

January	78,215	3,257	155	542,905	179,566	804,098
February	76,100	2,430	.....	562,863	108,961	750,354
March	79,670	2,360	310	717,963	256,906	1,056,209
April	84,923	2,428	306	860,274	191,700	1,130,721
May	74,877	2,840	1,621	968,538	168,713	1,216,589
June	66,839	2,459	3,446	1,010,049	159,072	1,241,865
July	64,190	3,265	774	953,530	150,960	1,172,719
August	53,899	2,798	.....	802,200	158,002	1,016,899
September	54,960	2,488	.....	812,062	140,990	1,010,500
October	57,891	2,157	.....	905,558	130,163	1,095,769
November	51,852	2,124	.....	814,545	125,095	993,616
December	47,232	2,538	.....	831,073	119,646	1,000,489
Total	790,648	31,144	6,612	9,781,560	1,888,864	12,498,828

The following table gives a statement of the production and value of petroleum at wells in Louisiana in 1912 and 1913, by districts:

Production and value of petroleum in Louisiana in 1912 and 1913, by districts, in barrels, with increase or decrease in barrels and percentage of increase and decrease.

District	1912			1913			Increase (+) or decrease (−).	Per centage of increase (+) or decrease (−).
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.		
Caddo	7,177,949	$5,419,541	$0.755	9,781,560	$9,812,342	1.003	+2,603,611	+ 36.27
Jennings	1,105,711	968,393	.876	790,648	769,917	.974	− 315,063	− 28.49
Welsh	22,140	18,655	.843	31,144	26,745	.859	+ 9,004	+ 40.67
Anse la Butte	25,000	19,605	.784	6,612	5,290	.800	− 18,388	− 73.55
Vinton	932,639	597,633	.641	1,888,864	1,641,637	.869	+ 956,225	+102.53
Total	9,263,439	7,023,827	.758	12,498,828	12,255,931	.981	+3,235,389	+ 34.93

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Production, value, and average price per barrel of petroleum in the Caddo field, 1906–1913, in barrels.

Year.	Caddo, La.			Marion County, Tex.			Total.		
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.
1906.....	3,358	$2,183	$0.650	.....	.....	.....	3,358	$2,183	$0.650
1907.....	50,000	38,863	.777	.....	.....	.....	50,000	38,863	.777
1908.....	499,937	214,048	.428	.....	.....	.....	499,937	214,048	.428
1909.....	1,028,818	549,081	.533	.....	.....	.....	1,028,818	549,081	.533
1910.....	5,090,793	2,292,349	.451	251,717	$102,842	$0.409	5,342,510	2,395,191	.448
1911.....	6,995,828	3,653,725	.522	677,689	365,067	.539	7,673,517	4,018,792	.524
1912.....	7,177,949	5,419,541	.755	362,870	290,974	.802	7,540,819	5,710,515	.757
1913.....	9,781,560	9,812,342	1.003	262,392	261,965	.998	10,043,952	10,074,307	1.003
Total..	30,628,243	21,982,132	.718	1,554,668	1,020,848	.657	32,132,911	23,002,980	.716

Production of petroleum in Caddo field, 1906–1913, by districts, with increase or decrease and percentage of increase or decrease, in barrels.

Year.	Caddo, La.			Marion County, Tex.			Total.		
	Quantity.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).	Quantity.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).	Quantity.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).
1906.....	3,358	.....	.....	.....	.....	.....	3,358	.....	.....
1907.....	50,000	+ 46,642	+1,388.98	.....	.....	.....	50,000	+ 46,642	+1,388.98
1908.....	499,937	+ 449,937	+ 899.87	.....	.....	.....	499,937	+ 449,937	+ 899.87
1909.....	1,028,818	+ 528,881	+ 105.79	.....	.....	.....	1,028,818	+ 528,881	+ 105.79
1910.....	5,090,793	+4,061,975	+ 394.8	251,717	.....	.....	5,342,510	+4,313,692	+ 419.29
1911.....	6,995,828	+1,905,035	+ 37.42	677,689	+ 425,972	+ 169.22	7,673,517	+2,331,007	+ 43.63
1912.....	7,177,949	+ 182,121	+ 2.60	362,870	− 314,819	− 46.45	7,540,819	− 132,698	− 1.76
1913.....	9,781,560	+2,603,611	+ 36.27	262,392	− 100,478	− 3.12	10,043,952	+2,503,133	+ 3.61
Total..	30,628,243	.....	.....	1,554,668	.....	.....	32,132,911	.....	.....

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RAILROAD SHIPMENTS.

The following table gives a statement of shipments of petroleum from stations on the line of the Louisiana Western Railroad and of the Kansas City Southern Railway in Louisiana during the years 1912 and 1913, by months:

Rail shipments of petroleum from stations on the lines of the Louisiana Western Railroad and the Kansas City Southern Railway in Louisiana in 1912 and 1913, by months, in barrels.

1912.[a]

Month.	Anse la Butte.	Caddo oil.				Jennings oil.			Vinton.	Total.
		Lewis.	Moorings-port.	Oil City.	Vivian.	Egan.	Jennings.	Mermentau.		
January	.....	46,986	6,437	68,266	15,306	2,786	2,816	3,173	.....	145,770
February	.....	42,973	71,754	57,430	9,550	774	6,878	995	.....	190,354
March	465	47,097	3,319	105,162	10,610	3,405	11,520	727	25,386	207,691
April	.....	38,086	6,205	68,467	12,062	3,250	6,262	943	40,410	175,685
May	1,210	37,763	235	44,299	6,551	4,798	4,873	1,715	32,909	134,353
June	2,017	29,006	.....	42,335	4,394	2,012	1,398	677	28,030	109,869
July	1,776	36,830	380	61,218	3,980	8,927	2,150	2,046	35,010	152,317
August	.....	55,644	190	60,645	4,157	12,387	1,850	4,593	27,942	167,408
September	611	37,148	.....	26,538	4,843	17,662	3,302	1,987	28,111	120,202
October	1,043	53,275	190	33,504	3,509	10,209	4,613	1,851	27,092	135,286
November	464	51,100	.....	28,323	2,346	2,756	2,800	3,410	19,919	111,118
December	.....	61,216	374	50,414	854	6,456	1,304	4,199	27,958	152,775
Total	7,586	537,124	89,084	646,601	78,162	75,422	49,766	26,316	292,767	1,802,828

[a] These are the official figures, calculation being made on the basis of 310.8 pounds of crude petroleum to a barrel of 42 gallons.

1913.

Month.	Anse la Butte.	Caddo oil.					Jennings oil.			Vinton.	Total.
		Lewis.	Moorings-port.	Oil City.	Vivian.	Mansfield.	Egan.	Jennings.	Mermentau.		
January	155	10,384	567	39,303	7,161	694	3,163	13,858	10,177	27,938	113,400
February	.....	11,431	8,448	40,709	1,403	967	2,719	19,203	4,798	19,645	109,323
March	310	17,564	23,205	40,436	1,513	194	7,779	24,101	848	17,100	133,050
April	306	17,869	55,372	29,765	5,407	.....	5,401	55,422	5,888	8,161	183,591
May	1,621	23,282	41,415	43,096	2,628	.....	8,251	69,024	15,773	974	206,064
June	3,446	22,229	.....	49,684	1,210	1,921	9,045	27,722	15,282	.....	130,539
July	774	24,306	.....	49,706	1,537	19,970	5,926	22,144	13,722	.....	138,085
August	.....	43,173	.....	60,203	2,471	13,847	2,895	17,114	15,334	.....	155,037
September	.....	15,941	.....	53,845	3,203	16,788	8,126	31,038	27,856	.....	156,797
October	.....	4,905	.....	43,073	2,664	19,810	2,179	26,480	8,158	.....	107,269
November	.....	14,942	.....	50,802	3,446	16,383	1,393	21,062	15,600	.....	123,628
December	.....	5,117	.....	49,129	2,233	62,809	2,106	25,956	6,285	.....	153,635
Total	6,612	211,143	129,007	549,751	34,876	153,383	58,983	353,124	139,721	73,818	1,710,418

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WELL RECORD.

In the following tables are given the well record for Louisiana for the years 1909 to 1913, inclusive:

Number of wells completed in Louisiana, 1909–1913, by districts.

District.	Oil.					Dry.					Total completed.[a]				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Caddo	69	124	246	239	356	33	54	63	62	92	121	[b]226	341	353	[c]518
Coastal Louisiana:															
Anse la Butte	5	3	.....	3	5	4	1	1	4	1	9	4	1	7	6
Calcasieu	.....	.....	.....	.....	4	.....	.....	.....	.....	1	.....	.....	.....	.....	5
Cameron	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	2
Evangeline	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
Jennings	28	16	4	24	19	23	6	1	9	9	51	22	5	33	28
Pine Prairie	.....	.....	.....	1	2	.....	.....	.....	5	4	.....	.....	.....	6	6
Rapides	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
Terrebonne	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Vinton	.....	8	54	31	45	.....	3	27	7	34	.....	11	96	38	79
Welsh	1	5	5	.....	6	1	.....	3	.....	4	2	5	10	.....	10
Total	103	156	309	298	437	61	64	95	87	149	183	268	453	437	657

[a] Including gas wells.
[b] Including Marion County, Tex.
[c] Including Bossier, De Soto, and Sabine parishes.

Number of oil wells and dry holes drilled in Louisiana in 1913, by districts and months.

District.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total, 1913.		Total, 1912.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Caddo[a]	31	9	20	3	17	9	36	1	33	4	14	7	39	9	25	6	39	10	30	10	32	13	40	11	356	92	239	62
Coastal Louisiana:																												
Anse la Butte	.....	.....	.....	1	1	.....	.....	.....	1	.....	1	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	.....	5	1	3	4
Calcasieu	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	2	1	1	.....	.....	.....	.....	.....	4	1	.....	.....
Cameron	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....
Evangeline	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	.....
Jennings	3	2	1	1	2	.....	4	.....	1	.....	3	2	2	1	1	.....	1	.....	1	.....	.....	.....	2	.....	19	9	24	9
Pine Prairie	.....	.....	1	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	2	4	1	5
Rapides	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....
Vinton	2	1	3	4	8	.....	4	9	4	1	5	7	9	5	6	1	1	1	.....	.....	2	.....	1	5	45	34	31	7
Welsh	.....	.....	.....	1	.....	.....	1	1	.....	.....	.....	1	1	.....	2	1	.....	.....	2	.....	.....	.....	.....	.....	6	4	.....	.....
Total	36	12	25	10	28	9	45	16	39	5	23	17	51	15	37	10	43	12	34	11	34	14	42	18	437	149	298	87

[a] Includes in 1913 Bossier, De Soto, and Sabine parishes.

Number of oil wells drilled in Louisiana, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	14	5	13	8	13	9	12	9	5	4	6	5	103
1910	7	4	8	5	12	16	20	19	17	15	16	17	156
1911	20	33	49	26	39	29	27	18	21	14	16	17	309
1912	12	19	19	14	30	28	25	28	34	27	37	25	298
1913	36	25	28	45	39	23	51	37	43	34	34	42	437

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Number of dry holes drilled in Louisiana, 1909–1913, by months.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	6	8	6	9	7	6	15	2	10	2	4	5	80
1910	9	10	14	19	6	6	1	14	9	.....	9	15	64
1911	12	15	12	6	9	6	9	8	3	4	5	6	95
1912	2	8	1	6	4	11	7	6	15	15	8	4	87
1913	12	10	9	16	5	17	15	10	12	11	14	18	149

Total number of wells completed in Louisiana, 1909–1913, by months.[a]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1909	20	13	19	17	20	15	27	11	15	6	10	10	183
1910	16	14	22	24	18	22	21	33	26	15	25	32	268
1911	32	51	64	33	52	38	39	42	32	20	25	25	453
1912	17	31	22	21	34	46	37	43	57	44	51	34	437
1913	53	44	44	65	49	44	73	54	58	51	51	71	657

[a] Including gas wells.

Initial daily production of new wells completed in Louisiana in 1913, by districts and months, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total, 1913.	Total, 1912.
Caddo[a]	6,499	11,615	10,585	20,865	24,246	11,636	12,735	19,189	6,250	9,890	3,397	15,048	151,955	84,098
Coastal Louisiana:														
Anse la Butte	.....	.....	125	.....	2,000	75	.....	12	.....	.....	.....	150	2,362	590
Calcasieu	.....	.....	.....	.....	.....	.....	.....	600	80	1,100	.....	2,500	1,780	.....
Jennings	440	375	550	2,665	30	105	240	100	150	158	.....	.....	4,813	5,905
Pine Prairie	.....	60	.....	.....	.....	.....	.....	20	.....	.....	.....	.....	80	1,050
Vinton	14,125	360	15,960	5,300	710	2,150	2,675	2,675	100	.....	50	.....	46,605	17,975
Welsh	.....	.....	.....	30	.....	.....	25	30	.....	15	.....	.....	100	.....
Total	21,064	12,410	27,220	28,860	26,986	13,966	15,675	22,626	6,580	11,163	3,447	17,698	207,695	109,618

[a] Includes in 1913 Bossier, De Soto, and Sabine parishes.

Total and average initial daily production of new wells in Louisiana, 1909–1913, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1909	1910	1911	1912	1913	1909	1910	1911	1912	1913
Caddo	8,750	[a]139,945	169,123	84,098	[b]151,955	127.0	1,128.6	687.5	351.9	426.8
Coastal Louisiana:										
Anse la Butte	955	735	.....	590	2,362	191.0	245.0	.....	196.7	472.4
Calcasieu	.....	.....	.....	.....	1,780	.....	.....	.....	.....	445.0
Jennings	11,745	3,230	490	5,905	4,813	419.0	201.9	120.0	246.0	253.3
Pine Prairie	.....	.....	.....	1,050	80	.....	.....	.....	1,050.0	40.0
Vinton	.....	11,100	73,550	17,975	46,605	.....	1,387.5	1,362.0	579.8	1,035.7
Welsh	.....	165	115	.....	100	.....	83.0	23.0	.....	16.7
Total	21,450	155,175	243,268	109,618	207,695	210.3	994.7	787.3	432.5	475.3

[a] Includes Marion County, Tex.
[b] Includes Bossier, De Soto, and Sabine parishes.

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Total initial daily production of new wells in Louisiana, 1909–1913, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1909.....	3,900	865	2,260	4,730	1,250	1,560	1,720	570	640	160	2,625	1,170	21,450	1,788
1910.....	1,750	1,345	5,320	3,520	11,040	20,650	8,270	12,245	33,560	30,840	16,215	10,420	155,175	12,931
1911.....	35,275	29,325	17,110	38,595	62,150	6,980	5,405	4,505	23,465	4,886	5,292	10,280	243,268	20,272
1912.....	10,855	5,257	10,070	18,300	11,447	3,583	4,931	3,391	17,605	5,600	13,631	4,948	109,618	9,135
1913.....	21,064	12,410	27,220	28,860	26,986	13,966	15,675	22,626	6,580	11,163	3,447	17,698	207,695	17,308

CALIFORNIA OIL FIELD.

GENERAL CONDITIONS.

Although the production of oil in California increased to almost 100,000,000 barrels (97,788,525) in 1913, and although the gusher development in the Midway field in the lower end of the Sunset field, and in the Fullerton field, showed that no forecast can yet be made as to what maximum the California production may reach, there was, nevertheless, a great steadying tendency evident throughout the State. In 1912 began the passing of the stage of fraudulent companies, characteristic of every oil development. The completion of this was aided in 1913 by legal enactment providing for the scrutiny of oil corporations. Another steadying influence during the year was the increased development of refining facilities at Port Costa and elsewhere on San Francisco Bay, at El Segundo in Los Angeles County, and at Port Harford in San Luis Obispo County, as well as the development of a definite policy among the producing companies to introduce topping plants. In consequence the quantity of crude petroleum sold for fuel was considerably decreased. The reduced material has a better flash point and in general is safer for fuel purposes, and the tops are salable to the refining companies. The fact that the oil produced is changing in character, being progressively lighter in specific gravity and containing more gasoline and kerosene, is a feature of great significance for the oil trade in 1914.

At the beginning of the year 1913, the producers of heavy oil (oil with Baumé gravity of 18° or lower) were unable to dispose of their output to the Standard Oil Co. of California and temporarily closed in a production amounting to about 25,000 barrels a day pending arrangements for disposing of it at a satisfactory price. This storing, together with a steady consumption brought about a condition of about equal production and consumption at the beginning of the year.

After efforts to find independent markets for the heavy oil, the producers of this grade gradually turned it over to the Independent Agency which had begun to draw upon its stocks.

Early in the year the Sunset field was extended southeast by the drilling of large wells on the Maricopa flats. With their yield production again began to exceed consumption, so that by the end of the year the production had reached almost 98,000,000 barrels, against 87,272,593 barrels in 1912, and oil was again going into storage.

The fact that this great increase involved no discovery of new oil pools and merely the extension of the Sunset pools southeast is significant as to the conditions of the occurrence of oil in California. The increase was due to the opening of gushers of large capacity during

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the course of ordinary developments within well-known oil pools. In fact, the reason for the increase in production is well epitomized by the following table showing the development during the year of gushers which had an initial production of 1,000 barrels, or more, a day:

List of wells completed in California fields during 1913 with estimated daily output of 1,000 barrels or more, by months.

Month.	District.	Location. S.	T.	R.	Depth. Feet.	Daily capacity.	Gravity (°B.)
January:							
Lakeview No. 2 Oil Co	Maricopa	4	11	23	2,635	1,500	25.5
Kern Trading & Oil Co	do	5	11	23	2,496	1,800	26.8
Union Oil Co	Coyote	13	3	10	3,193	1,350	23.0
February:							
Maricopa Queen Oil Co	Maricopa	32	12	23	2,405	4,000	23.5
Pacific Crude Oil Co	Midway	32	31	23	3,160	1,200	25.5
Associated Oil Co	do	34	31	23	3,237	3,300	23.5
Kern Trading & Oil Co	do	1	32	23	2,500	1,000	29.4
Amalgamated Oil Co	Coyote	13	3	10	3,245	1,500	22.4
Orange Oil Co	Fullerton					1,400	
March:							
Mays Consolidated Oil Co	Midway	28	31	23	3,000	2,500	26.8
Honolulu Cons. Oil Co	do	6	32	24	2,473	2,000	27.4
Kern Trading & Oil Co	do	11	32	24	3,203	1,600	26.8
Amalgamated Oil Co	Coyote	13	3	10	3,258	1,200	23.0
Universal Oil Co	Lost Hills	32	26	21		1,500	
Union Oil Co	Sunset-Midway	34	31	23		5,000	
April:							
General Petroleum Co	Lost Hills	4	27	21	1,600	1,000	34.6
Standard Oil Co	Sunset-Midway	36	31	23	2,500	20,000	
Union Oil Co	do	34	31	28		7,000	
Standard Oil Co	Lost Hills	4	27	21	1,720	1,200	
May:							
California Oil Fields (Ltd.)	Coalinga	34	19	15	2,722	1,000	24.3
Miocene Oil Co	Maricopa	32	12	23	2,523	1,000	21.6
Amalgamated Oil Co	Fullerton					1,900	
Maricopa Queen Oil Co	Sunset-Midway	32	12	23		6,000	
June:							
Turner Oil Co	Coalinga	22	19	15	3,512	2,700	31.0
Midway Northern Oil Co	Maricopa	32	12	23	2,565	2,000	23.0
Standard Oil Co	Midway	10	32	23	3,229	1,000	26.4
Standard Oil Co	do	36	31	23	2,500	1,000	26.9
General Petroleum Co	do	32	32	24	2,522	1,400	17.5
General Petroleum Co	do	32	31	24	3,350	2,200	26.8
Amalgamated Oil Co	Fullerton					2,000	
July:							
Turner Oil Co	Coalinga	22	19	15	4,020	2,500	30.5
Standard Oil Co	Midway	36	31	23	2,480	10,000	22.5
Union Oil Co	Santa Maria	Newlove.			3,250	1,200	30.0
Standard Oil Co	Coyote	14	3	11	3,500	3,400	26.0
August:							
Pacific Crude Oil Co	Midway	32	31	23	3,178	1,200	25.0
September:							
Standard Oil Co	Coyote	14	3	11	3,590	2,000	26.0
October:							
Kern Trading & Oil Co	Coalinga	35	19	15	3,729	2,100	30.0
Caribou Oil & Mining Co	Midway	28	31	23	3,050	1,200	26.0
Standard Oil Co	Coyote	14	3	11	3,425	10,000	31.6
November:							
Mays Consolidated Oil Co	Midway	28	31	23	2,730	1,200	27.7
Kern Trading & Oil Co	do	3	32	23	3,415	1,000	28.2
Murphy Oil Co	Coyote	18	3	10	3,555	1,500	28.0
Monte Cristo Oil Co	Sunset				2,750	10,000	
December:							
Obispo Oil Co	Maricopa	32	12	24	2,565	10,000	25.2
Union Oil Co	Midway	34	31	23	3,282	1,200	23.0
Union Oil Co	do	34	31	23	3,190	10,000	23.0
Kern Trading & Oil Co	do	1	32	23	3,284	3,400	29.0
Northern Exploration Co	do	22	31	23		3,000	

It will be seen that these gushers were well scattered over the producing regions of California, but that the large gushers were particularly important as to number or size in the Maricopa, Midway, Sunset, and Fullerton fields.

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A feature of especial importance was the drilling by the Kern Trading & Oil Co. of a gusher yielding an initial production of 1,800 barrels a day out on the Maricopa Flats at the southeastern end of the Sunset fields (sec. 5, T. 11 N., R. 23) at about 2,500 feet. This was followed by a gusher of 1,800 barrels by the Lakeview Number Two Oil Co. on adjoining sec. 4. Several other wells yielding more than 1,000 barrels a day were drilled during the year, and added materially to the production.

A table following, page 1069, shows the production in the different fields in 1913 as compared with 1912. The table gives evidence of a declining production in the Kern River field, but it should be noted that there is possibility of extending this field to the northwest if the conditions of demand should justify it.

In the Coalinga district the year produced many eventful features, including extensions of territory to the east and the discovery of additional deep sands that yielded petroleum containing paraffin and larger proportions of light oils. The value of the field was indicated by the sale late in the year of the California Oil Fields (Ltd.) to the Shell Trading & Transportation Co., an ally of the Royal Dutch Syndicate.

The Santa Maria field benefited by advances in technologic methods by which the oils were topped and dehydrated with markedly greater efficiency. These developments included the successful introduction of the Cottrell electric dehydration process. The adoption of the Trumble and the Dyer topping and dehydrating processes and the great advance in methods for obtaining gasoline from natural gas were among the striking achievements of the year; but although less spectacular, the economies effected by many minor improvements in the great refineries at Point Richmond, Oleum, and El Segundo contributed perhaps equally to the general problem of efficient refining.

In transportation the new pipe line of the General Petroleum Co. over Tehachapi Pass effected cheaper transportation to the south, and the natural-gas line to Los Angeles was equally advantageous. Meanwhile, several new tank oil carriers and oil-burning steamships were added to the Pacific coast trade and aided in increasing consumption.

TRANSPORTATION.

PIPE-LINE TRANSPORTATION.

The following table gives the approximate capacity of the pipe lines of California. It has been stated that an 8-inch pipe line is capable of delivering 30,000 barrels a day of California oil. This possibly has been done with the light oils of California when heated to a high temperature; but this quantity is ordinarily in considerable excess of the possibilities, and the capacity of the oil pipe lines of the State is due to the fact that there are many loops in them which increase their capacity, as is clear from the following description:

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Pipe lines of the San Joaquin Valley.

STANDARD OIL CO.

	Estimated daily capacity in barrels.
Two 8-inch trunk lines 280 miles long from Kern River district to San Francisco Bay, with 115 miles of 12-inch loop; two 8-inch branch lines 32 miles long from Kern River to Midway, with 14 miles of 12-inch loop	65,000
One 8-inch branch line 29 miles long from Coalinga to Mendota, with 20 miles of 6-inch loop	28,000
One 8-inch branch line 20 miles long from Lost Hills to Pond	20,000

SOUTHERN PACIFIC RAILROAD.

Associated Pipe Line Co.:	
One 8-inch trunk line 284 miles long from Kern River to San Francisco Bay	14,000
One 8-inch trunk line 279 miles long from Sunset district to San Francisco Bay	30,000
One 6-inch trunk line 110 miles long from Coalinga district to Monterey Bay	12,000

UNION OIL CO.

Producers' Transportation Co.:	
Two 8-inch trunk lines 70 miles long from Junction to Port Harford	40,000
Five 8-inch branch lines to Coalinga, Kern River, Sunset, Midway, and Lost Hills	23,000

GENERAL PETROLEUM CO.

General Pipe Line Co.: This company has one 8-inch pipe line from Midway district to Los Angeles Harbor, a distance of 154 miles, the estimated daily capacity of which is about 30,000 barrels. A branch 8-inch line 52 miles long runs from Lebec station to Mohave, where the oil is topped before shipping by rail to south and east of Mohave.

Pipe lines of the Santa Maria and Santa Clara districts.

STANDARD OIL CO.

	Estimated daily capacity in barrels.
One 8-inch line 32 miles long from Orcutt to Port San Luis, estimated capacity	30,000
One 8-inch line 33 miles long from Orcutt to Port Harford (idle), belonging to Refining & Producing Oil Co	20,000

UNION OIL CO.

This company, through its subsidiaries, controls—	
One 8-inch and one 6-inch line 34 miles long from Santa Maria to Port Harford, estimated capacity	30,000

OTHER COMPANIES.

Pinal-Dome Oil Co.:	
One 4-inch line from Santa Maria field to a topping plant at Bettaravia for crude.	
One 2-inch line from Santa Maria field to a topping plant at Bettaravia for gasoline.	

Pipe lines from the Santa Clara Valley.

STANDARD OIL CO.

One 2-inch and 3-inch, 44 miles long from Newhall field through Santa Clara Valley fields to Ventura, estimated daily capacity	1,500

UNION OIL CO.

One 2-inch, 3-inch, and 4-inch line 35 miles long from Torrey Canyon to Ventura, estimated daily capacity	2,000

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Pipe lines from Los Angeles to Puente Hills.

STANDARD OIL CO.

This company owns one 6-inch and one 8-inch line, 23 miles long, connecting the Puente Hills district to the refinery at El Segundo, near the coast, about 15 miles southwest of Los Angeles. This line has an estimated capacity of 27,000 barrels a day.

SOUTHERN PACIFIC RAILROAD CO.

Amalgamated Oil Co.: The Los Angeles fields are connected to a refinery near the city of Los Angeles by a pipe line having an estimated capacity of 28,800 barrels a day.

The total pipe-line carrying capacity in California at the end of 1913 was as follows:

	Barrels.
Daily carrying capacity of San Joaquin Valley	191,000
Daily carrying capacity of Santa Maria system of pipe lines	100,000
Daily carrying capacity of Santa Clara Valley system of pipe lines to Ventura	3,500
Daily carrying capacity of pipe lines from Los Angeles and Puente Hills districts to Los Angeles city and harbor	106,800
Daily carrying capacity of all lines in California	401,300

RAILROAD TRANSPORTATION.

The Standard Oil Co. leases from the Union Tank Line Co. 12,400 cars; the Southern Pacific Co. is equipped with about 2,850 cars; the Atchison, Topeka & Santa Fe Railway with 2,566 cars; the San Pedro, Los Angeles & Salt Lake Railroad with 205 cars. The Associated Oil Co. has about 340 cars, the Union Oil Co. about 112, and the Western Pacific Railway Co. about 170. These cars have a capacity of between 200 and 300 barrels.

TANK-STEAMER TRANSPORTATION.

The tank steamers owned by the principal oil companies of California and used in transporting crude oil and residues from California ports to Oregon, Washington, Canada, Hawaii, Japan, and other foreign countries are shown in the following table:

Number and capacity of tank steamers transporting crude oil and residues from California in 1913.

Company.	Number.	Capacity, (barrels of 42 gallons.)
Standard Oil Co	26	431,785
Union Oil Co	24	666,905
Associated Oil Co	14	302,403
General Petroleum Co	12	378,119
Total	76	1,779,212

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PRODUCTION.

The production of petroleum in California from 1876 to 1913, inclusive, is given in the following table:

Production of petroleum in California, 1876–1913, in barrels.

Year.	Production.	Percentage of total production.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).	Value.	Yearly average price per barrel.
1876	12,000	0.13			$30,000	$2.50
1877	13,000	.10	+ 1,000	+ 8.33	32,500	2.50
1878	15,227	.10	+ 2,227	+ 17.13	35,174	2.309
1879	19,858	.10	+ 4,631	+ 30.41	45,872	2.31
1880	40,552	.15	+ 20,694	+104.21	93,675	2.309
1881	99,862	.36	+ 59,310	+146.26	230,727	2.31
1882	128,636	.42	+ 28,774	+ 28.81	297,149	2.309
1883	142,857	.61	+ 14,221	+ 11.06	330,000	2.31
1884	262,000	1.08	+ 119,143	+ 83.40	605,220	2.31
1885	325,000	1.49	+ 63,000	+ 24.46	750,750	2.31
1886	377,145	1.34	+ 52,145	+ 16.05	870,205	2.307
1887	678,572	2.39	+ 301,427	+ 79.92	1,567,501	2.31
1888	690,333	2.50	+ 11,761	+ 1.73	1,390,666	2.01
1889	303,220	.86	− 387,113	− 56.08	356,048	1.174
1890	307,360	.67	+ 4,140	+ 1.37	384,200	1.25
1891	323,600	.59	+ 16,240	+ 5.28	401,264	1.24
1892	385,049	.76	+ 61,449	+ 18.99	561,333	1.45
1893	470,179	.97	+ 85,130	+ 22.11	608,092	1.29
1894	705,969	1.43	+ 235,790	+ 50.15	823,123	1.16
1895	1,208,482	2.28	+ 502,513	+ 71.18	849,082	.70
1896	1,252,777	2.05	+ 44,295	+ 3.67	1,240,990	.99
1897	1,903,411	3.15	+ 650,634	+ 51.93	1,713,102	.90
1898	2,257,207	4.08	+ 353,796	+ 18.59	1,917,596	.85
1899	2,642,095	4.63	+ 384,888	+ 15.67	2,508,751	.95
1900	4,324,484	6.80	+ 1,682,389	+ 63.67	4,076,975	.943
1901	8,786,330	12.66	+ 4,461,846	+103.17	4,974,540	.566
1902	13,984,268	15.75	+ 5,197,938	+ 59.16	4,873,617	.348
1903	24,382,472	24.27	+10,398,204	+ 74.36	7,399,349	.303
1904	29,649,434	25.33	+ 5,266,962	+ 21.60	8,265,434	.279
1905	33,427,473	24.81	+ 3,778,039	+ 12.74	8,201,816	.245
1906	33,098,598	26.17	− 328,875	− .98	9,553,430	.289
1907	39,748,375	23.93	+ 6,649,777	+ 20.09	14,699,956	.370
1908	44,854,737	25.13	+ 5,106,362	+ 12.87	23,433,502	.523
1909	55,471,601	30.29	+10,616,864	+ 23.67	30,756,713	.554
1910	73,010,560	34.84	+17,538,959	+ 31.62	35,749,473	.490
1911	81,134,391	36.80	+ 8,123,831	+ 11.13	38,719,080	.477
1912	[a] 87,272,593	39.152	+ 6,138,202	+ 7.57	39,624,501	.454
1913	97,788,525	39.356	+10,515,932	+ 12.05	45,709,400	.467
Total	641,498,232	20.90			293,681,136	.458

[a] Includes small quantity from Alaska.

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The following table shows the production and value of petroleum in California in 1912 and 1913, by districts and counties:

Production and value of petroleum in California in 1912 and 1913, by districts and counties, in barrels.

District and county.	1912			1913		
	Quantity.	Value.	Price per barrel.	Quantity.	Value.	Price per barrel.
Coastal and southern:						
Los Angeles County—						
Los Angeles city	344,789	$211,896	$0.615	320,804	$176,398	$0.550
Newhall						
Puente						
Salt Lake-Sherman						
Whittier						
Orange County—						
Fullerton	[a]16,685,230	[a]10,186,018	.615	19,777,885	11,027,878	.557
Ventura County—						
Santa Paula						
Santa Barbara County—						
Lompoc						
Santa Maria						
Summerland	65,376	44,295	.677	66,000	44,150	.669
San Luis Obispo County	20,123	11,977	.595	42,216	25,368	.601
Santa Clara County						
San Joaquin Valley:						
Fresno County—						
Coalinga	19,911,820	8,768,303	.441	19,302,654	8,507,714	.442
Kern County—						
Lost Hills	1,367,359	652,927	.477	3,440,595	2,209,909	.642
Kern River	12,558,439	5,399,914	.422	9,885,380	3,917,273	.396
McKittrick	5,881,996	2,350,096	.399	6,391,716	2,485,492	.389
Midway	23,928,368	9,713,362	.405	30,000,336	14,075,950	.469
Sunset	6,509,093	2,285,713	.351	8,560,939	3,238,368	.378
Total	50,245,255	20,402,012	.406	58,278,966	25,929,892	.445
Grand total	87,272,593	39,624,501	.454	97,788,525	45,709,400	.467

[a] Includes small quantity from Alaska.

The following table shows the production of petroleum in California, by counties, from 1904 to 1913, inclusive:

Production of petroleum in California, 1904–1913, by counties, in barrels.

Year.	Fresno.	Kern.	Los Angeles.	Orange.	Santa Barbara.	Ventura.	San Mateo.	Santa Clara.	Total.
1904	5,114,958	19,608,045	2,102,892	1,473,335	789,006	517,770	1,500	41,928	29,649,434
1905	10,967,015	14,487,967	3,469,433	1,429,688	2,684,837	337,970	50,563		33,427,473
1906	7,991,039	14,520,854	3,449,119	2,032,637	4,774,361	299,124	[a] 31,464		33,098,598
1907	8,871,723	15,652,156	3,477,235	2,604,982	8,708,077	357,094	[a] 77,108		39,748,375
1908	10,386,168	18,132,893	4,692,495	3,358,714	7,816,682	379,044	[a] 88,741		44,854,737
1909	14,795,459	23,831,768	16,774,195				[a] 70,179		55,471,601
1910	18,387,750	37,896,727	16,665,678				[b] 60,405		73,010,560
1911	18,483,751	45,921,712	16,708,466				[b] 20,462		81,134,391
1912	19,911,820	50,245,255	[c] 17,095,395				[b] 20,123		87,272,593
1913	19,302,654	58,278,966					[b] 42,216		97,788,525

[a] Includes oil produced in San Luis Obispo County.
[b] Production of Santa Clara and San Luis Obispo counties.
[c] Includes small quantity from Alaska.

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Production of petroleum in California in 1912 and 1913, by districts and counties, with increase or decrease and percentage thereof, in barrels.

District and county.	1912	1913	Increase.	Decrease.	Per centage.	
					Increase.	Decrease.
Coastal and southern:						
Los Angeles County—						
Los Angeles city	344,789	320,804	.....	23,985	.....	7.48
Newhall						
Puente						
Salt Lake-Sherman						
Whittier						
Orange County—						
Fullerton	a16,685,230	19,777,885	3,192,655	.....	19.67	.....
Ventura County—						
Santa Paula						
Santa Barbara County—						
Lompoc						
Santa Maria						
Summerland	65,376	66,000	624	.....	.95	.....
San Luis Obispo County	20,123	42,216	22,093	.....	109.79	.....
Santa Clara County						
San Joaquin Valley:						
Fresno County—						
Coalinga	19,911,820	19,302,654	.....	609,166	.....	3.06
Kern County—						
Lost Hills	1,367,359	3,440,595	2,073,236	.....	151.62	.....
Kern River	12,558,439	9,885,380	.....	2,673,059	.....	21.28
McKittrick	5,881,996	6,391,716	509,720	.....	8.66	.....
Midway	23,928,368	30,000,336	6,071,968	.....	25.38	.....
Sunset	6,509,093	8,560,939	2,051,846	.....	31.52	.....
Total	50,245,255	58,278,966	8,033,711	.....	15.99	.....
Grand total	87,272,593	97,788,525	10,515,932	.....	12.05	.....

a Includes small quantity from Alaska.

Production, value, and average price per barrel of petroleum in California, 1904–1913, by districts, in barrels.

Year.	Coastal and southern.			San Joaquin Valley.			Total.		
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.
1904..	24,723,003	$4,952,255	$0.2003	4,926,431	$3,313,179	$0.672	29,647,434	$8,265,434	$0.279
1905..	25,454,982	5,351,572	.2102	7,972,491	2,850,274	.357	33,427,473	8,201,846	.245
1906..	22,511,893	5,191,060	.231	10,586,705	4,362,370	.412	33,098,598	9,553,430	.289
1907..	24,523,879	7,393,036	.301	15,224,496	7,306,920	.4799	39,748,375	14,699,956	.370
1908..	16,335,676	9,296,743	.569	28,519,061	14,136,759	.4956	44,854,737	23,433,502	.523
1909..	16,844,374	9,737,616	.578	38,627,227	21,019,097	.544	55,471,601	30,756,713	.554
1910..	16,726,083	10,532,080	.629	56,284,477	25,217,393	.448	73,010,560	35,749,473	.490
1911..	16,728,928	10,607,280	.904	64,405,463	28,111,800	.436	81,134,391	38,719,080	.477
1912..	a17,115,518	a10,454,186	.615	70,157,075	29,170,315	.416	87,272,593	39,624,501	.454
1913..	20,206,905	11,293,794	.557	77,581,620	34,435,606	.444	97,788,525	45,709,400	.467

a Includes small quantity from Alaska.

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FIELD REPORT.

The field report for California for 1912 and 1913 is shown in the following table:

Field report for California in 1912 and 1913, by counties and districts.

1912.

County and district.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Fresno County	956	142	11	56	1,042	63,137	13,032	76,169
Kern County:								
Lost Hills	20	51	4	15	56	17,521	2,280	19,801
Kern River	1,787	94	1	68	1,813	12,162	3,737	15,899
McKittrick	246	71	16	20	297	38,811	1,878	40,689
Midway	692	202	20	92	802	23,865	27,351	51,216
Sunset	330	82	6	32	380	16,033	11,855	27,888
Los Angeles County:								
Los Angeles City	413	1	.....	19	395	505	426	931
Newhall-Puente	133	.....	1	31	102	4,981	4,015	8,996
Salt Lake-Sherman	288	21	3	5	304	12,634	4,057	16,691
Whittier	109	13	1	4	118	5,566	184	5,750
Orange County	290	19	1	11	298	11,324	10,816	22,140
San Luis Obispo County	3	1	2	.....	4	13,524	1,178	14,702
San Mateo County	4	.....	.....	.....	4	.....	.....	.....
Santa Clara County	4	.....	.....	.....	4	50	6,000	6,050
Santa Barabra County:								
Lompoc-Santa Maria	255	23	2	29	249	82,708	34,696	117,404
Summerland	161	.....	.....	9	152	11	20	31
Ventura County	255	55	.....	11	299	27,118	78,546	105,664
Miscellaneous	1	1	3	.....	2	4,952	8,855	13,807
Total	5,947	776	71	402	6,321	334,902	208,926	543,828

1913.

Fresno County	1,042	91	16	47	1,086	47,201	12,644	59,845
Kern County:								
Lost Hills	56	83	2	3	136	12,664	5,570	18,234
Kern River	1,813	70	1	105	1,778	12,088	2,790	14,878
McKittrick	297	64	12	18	343	37,717	1,188	38,905
Midway	802	242	15	33	1,011	24,868	23,738	47,636
Sunset	380	63	6	11	432	10,317	13,829	24,146
Los Angeles County:								
Los Angeles city	395	.....	.....	9	386	406	341	747
Newhall-Puente	102	19	.....	6	115	6,975	298	7,273
Salt Lake-Sherman	304	12	2	9	307	11,677	3,476	15,153
Whittier	118	6	.....	2	122	2,999	1,368	4,367
Orange County	298	39	4	2	335	9,989	13,526	23,515
San Luis Obispo County	4	.....	.....	3	1	160	718	878
San Mateo County	4	.....	.....	.....	4	.....	600	600
Santa Clara County	4	.....	.....	1	3	.....	6,115	6,115
Santa Barbara County:								
Lompoc-Santa Maria	249	40	4	.....	289	94,489	31,050	125,539
Summerland	152	2	.....	20	134	54	.....	54
Ventura County	299	58	3	23	334	20,898	90,720	111,618
Miscellaneous	2	.....	2	1	1	800	1,640	2,440
Total	6,321	789	67	293	6,817	293,332	209,611	502,943

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COLORADO OIL FIELD.

GENERAL CONDITIONS.

Production of petroleum in Colorado has been declining continuously for five years, and the yield in 1913 amounted to only 188,799 barrels. The wells of the Florence field are unusually steady producers. The Oil and Gas Journal reports a well which has been pumped for 23 years and has yielded over 600,000 barrels.

There is oil awaiting transportation facilities in the Rangely field in Rio Blanco County, and oil and gas have been found near De Beque in Mesa County.

DE BEQUE.

After several unsuccessful attempts in drilling for oil at and near De Beque in the period since 1900, the Grand River Valley Oil & Gas Co. drilled a well in 1913 a short distance west of the town and found a good sand at 1,135 feet. The casing collapsed, but the gas pressure is sufficient to throw water intermittently to a height of 100 feet. Oil of 42° B. gravity was obtained as well as gas. A second test in 1914 reports a well of 100 barrels a day at 1900 feet, but it is troubled with water. The results have stimulated much leasing in the neighborhood, and a thorough test will be given.

OIL SHALES IN COLORADO AND UTAH.

In the field season of 1912 E. G. Woodruff, then of the United States Geological Survey, noted the presence of oil-bearing shales over large areas in the middle portion of the Green River formation in northwestern Colorado and northeastern Utah. He was directed to examine the economic possibilities of these shales during the summer of 1913. Many of these beds were measured and sampled, and the shales were distilled in lots of 100 or more pounds in a still operated at the deposits. The samples of oil and shale obtained were further tested by D. T. Day in the petroleum laboratory of the Survey. The results showed 10 to 68 gallons of crude oil to the ton of shale, with a probable average for better grades of shale of one barrel of oil to the ton. However, this average may not hold for extensive deposits of the rock. No tonnage estimate of the bituminous shales was attempted, but observations were made of their occurrence in various localities in Colorado and Utah and also in Wyoming and Nevada. It is known their acreage is very great, and in many places beds of notable thickness have been found. The latent possibilities of these resources are fully realized. The lands have not been withdrawn from entry, as the Secretary of the Interior deems it wise to avoid placing any hindrance in the way of private enterprise at the initial stage of development and to favor utilization by offering to real producers every premium the present law affords.

The Survey will make a more detailed examination of the Colorado and Utah shales, and the Bureau of Mines will probably take up the technologic study relating to their utilization. The shales yield, besides oil and large quantities of fixed gases, the usual ammonia characteristic of all such shales.

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It will be remembered that oil was extracted from bituminous shales in the United States in the early days of the oil industry; in fact, in 1860 there were more than 20 shale-treating plants in operation, which were put out of business by the low price of petroleum at that time.

Although the shale-oil industry long since ceased in the United States, it has persisted and apparently flourished in Great Britain and France. In 1904, the production of oil shale in Scotland amounted to 2,709,840 tons with a content of 63,000,000 gallons of crude oil, yielding marketable products of 2,517,296 gallons of naphtha, 16,991,748 gallons of burning oil, 37,997 tons of gas oil, 39,487 tons of lubricating oil, 22,476 tons of paraffin wax, and 49,600 tons of ammonia salts. In 1913 the production of oil shale in Scotland was 3,150,000 tons, from which about 65,000,000 gallons of oil was obtained and also a large quantity of ammonium sulphate. This yield of 20 gallons of oil to the ton of shale may be contrasted with the assumed average yield of 40 gallons from the Colorado and Utah shales. The cost of mining and treating the shale in Scotland for both oil and by-products is said to be about $1.85 a ton.

PRODUCTION.

In the following table is given the production of petroleum in Colorado, by fields and months, in 1912 and 1913:

Production of petroleum in Colorado in 1912 and 1913, by fields and months, in barrels.

Month.	1912				1913			
	Boulder.	Florence.	Other.[a]	Total.	Boulder.	Florence.	Other.[a]	Total.
January	1,430	13,398	20	14,848	1,269	17,464	25	18,758
February	865	14,425	20	15,310	1,273	14,795	25	16,093
March	1,740	15,410	21	17,171	1,570	15,708	26	17,304
April	967	16,723	21	17,711	1,318	14,099	26	15,443
May	1,586	16,401	21	18,008	1,315	14,811	26	16,152
June	1,126	15,151	21	16,298	1,141	14,752	26	15,919
July	1,509	17,638	21	19,168	914	14,993	26	15,933
August	1,267	16,215	21	17,503	314	14,203	26	14,543
September	1,109	16,423	21	17,553	575	14,307	26	14,908
October	1,306	16,266	21	17,593	1,007	14,153	26	15,186
November	1,154	15,944	21	17,119	704	13,687	26	14,417
December	1,245	16,504	21	17,770	396	13,721	26	14,143
Total	15,304	190,498	250	206,052	11,796	176,693	310	188,799

[a] Averaged.

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The following table gives the production of petroleum in Colorado from 1887 to 1913, inclusive:

Production, value, average price per barrel of petroleum in Colorado, 1887–1913, with the increase or decrease for each year, in barrels.

Year.	Production.	Percentage of total production.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−)	Value.	Average yearly price per barrel.
1887	76,295	0.27	.....	.....	$76,295	$1.000
1888	297,612	1.07	+ 221,317	+ 29.01	267,851	.900
1889	316,476	.90	+ 18,864	+ 6.34	280,240	.885
1890	368,842	.80	+ 52,366	+ 16.54	309,827	.84
1891	665,482	1.22	+ 296,640	+ 80.42	559,005	.84
1892	824,000	1.63	+ 158,518	+ 23.82	692,160	.84
1893	594,390	1.22	− 229,610	− 27.86	497,581	.838
1894	515,746	1.05	− 78,644	− 13.23	303,652	.589
1895	438,232	.83	− 77,514	− 15.02	336,010	.767
1896	361,450	.59	− 76,782	− 17.52	318,977	.883
1897	384,934	.64	+ 23,484	+ 6.50	332,122	.86
1898	444,383	.80	+ 59,449	+ 15.44	367,447	.827
1899	390,278	.69	− 54,105	− 12.18	404,110	1.035
1900	317,385	.50	− 72,893	− 18.67	323,434	1.019
1901	460,520	.66	+ 143,135	+ 45.09	461,031	1.000
1902	396,901	.45	− 63,619	− 13.81	484,683	1.220
1903	483,925	.48	+ 87,024	+ 21.93	431,723	.892
1904	501,763	.43	+ 17,838	+ 3.67	578,035	1.152
1905	376,238	.28	− 125,525	− 25.02	337,606	.897
1906	327,582	.26	− 48,656	− 12.93	262,675	.802
1907	331,851	.20	+ 4,269	+ 1.30	272,813	.822
1908	379,653	.21	+ 47,802	+ 14.40	346,403	.913
1909	310,861	.17	− 68,792	− 18.12	318,162	1.023
1910	239,794	.12	− 71,067	− 22.86	243,402	1.015
1911	226,926	.10	− 12,868	− 5.37	228,104	1.005
1912	206,052	.09	− 20,874	− 9.20	199,661	.973
1913	188,799	.07	− 17,253	− 8.37	174,779	.926
Total	10,426,370	.34	.....	.....	9,411,788	.903

Production of petroleum in Colorado in 1912 and 1913, by districts, showing increase or decrease and percentage of increase or decrease, in barrels.

District.	Production.		Increase.	Decrease.	Percentage.	
	1912	1913			Increase.	Decrease.
Boulder	15,304	11,796	.....	3,508	.....	22.92
Florence	190,498	176,693	.....	13,805	.....	7.25
Other districts	250	310	60	.....	24.00	.....
Total	206,052	188,799	.....	17,253	.....	8.37

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In the following table will be found the production and value of petroleum in the Boulder and Florence fields in Colorado from 1904 to 1913, inclusive:

Production, value, and average price per barrel of petroleum in Colorado, 1904–1913, by districts, in barrels.

Year.	Boulder.			Florence.			Total.		
	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.	Quantity.	Value.	Average price per barrel.
1904	18,167	$20,034	$1.103	483,596	$558,001	$1.153	501,763	$578,035	$1.152
1905	10,502	11,502	1.095	365,736	326,104	.892	376,238	337,606	.897
1906	48,952	53,847	1.0999	278,630	208,828	.7495	327,582	262,675	.802
1907	68,353	75,188	1.0999	263,498	197,625	.750	331,851	272,813	.822
1908	84,174	124,794	1.482	295,479	221,609	.750	379,653	346,403	.913
1909	85,709	129,812	1.514	225,062	187,900	.834	[a] 310,861	318,162	1.023
1910	42,186	63,420	1.503	193,482	174,332	.901	[b] 239,794	243,402	1.015
1911	37,973	50,393	1.327	187,341	175,763	.938	[b] 226,926	228,104	1.005
1912	15,304	19,130	1.250	190,498	180,281	.946	[c] 206,052	199,661	.973
1913	11,796	15,366	1.303	176,693	159,413	.902	[c] 188,799	174,779	.926

[a] Includes a small production in Garfield County.
[b] Includes production of Garfield and Rio Blanco counties.
[c] Includes production of Rio Blanco County.

FIELD REPORT.

Field report for Colorado in 1912 and 1913, by counties.

County.	Wells.									Acreage.					
	1912					1913				1912			1913		
	Productive, Jan. 1.	Completed.		Abandoned.	Productive, Dec. 31.	Completed.		Abandoned.	Productive, Dec. 31.	Fee.	Lease.	Total.	Fee.	Lease.	Total.
		Oil.	Dry.			Oil.	Dry.								
Boulder	26	....	....	7	19	2	....	3	18	2,978	745	3,723	2,567	445	3,012
Crowley	....	....	....	....	....	....	1	....	....	....	....	....	....	2,500	2,500
Fremont	54	11	13	15	50	4	12	3	51	2,326	1,780	4,106	2,366	1,820	4,186
Rio Blanco	39	4	....	1	42	2	....	21	23	4,000	8,800	12,800	4,800	800	5,600
Other	1	....	....	....	1	....	....	....	1	100	40	140	.....	40	40
Total	120	15	13	23	112	8	13	27	93	9,404	11,365	20,769	9,733	5,605	15,338

UTAH.

DEVELOPMENT.

Although no production is reported for Utah in 1913, more or less prospecting was carried on, especially in Uinta County, and an interesting well was being drilled north of Ogden.

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FIELD REPORT.

The field report for Utah in 1912 and 1913 is shown in the following table:

Field report for Utah in 1912 and 1913, by counties.

County.	Wells.									Acreage.					
	1912					1913				1912			1913		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.	Fee.	Lease.	Total.
		Oil.	Dry.			Oil.	Dry.								
Emery	....	....	....	....	....	....	2	....	....	.....	.....	.....	2,560	.....	2,560
Grand	....	....	....	....	....	....	1	....	....	.....	.....	.....	5,000	.....	5,000
San Juan	9	....	1	....	9	....	4	4	5	12,917	160	13,077	13,737	.....	13,737
Uinta	2	....	....	1	1	....	1	....	1	200	1,000	1,200	1,300	.....	1,300
Washington	6	....	....	3	3	....	....	....	3	600	.....	600	600	.....	600
Wayne	....	....	....	....	....	....	1	....	....	.....	.....	.....	.....	.....	.....
Total	17	....	1	4	13	....	9	4	9	13,717	1,160	14,877	23,197	.....	23,197

WYOMING.

DEVELOPMENT.

Increased transportation and refining facilities, affiliation of several companies, and satisfactory marketing contracts following the assurance of a large supply of crude oil, all combined to establish the petroleum industry on a permanent basis in the Salt Creek field tributary to Casper, in Natrona County, Wyo. Further the waning production in the Evanston region is offset by promising conditions at the opposite side of the State in the Big Horn country. All this has encouraged prospecting wherever oil has been found or wherever indications are promising in the State. Production increased from 1,572,306 barrels in 1912 to 2,406,522 barrels in 1913, and the total value increased from $798,470 to $1,187,232.

Negotiations begun in Paris early in the year and concluded in New York in March affiliated the Franco-Wyoming Oil Co., the Natrona Pipe Line & Refining Co., and the Dutch Maatschappij Salt Creek Petroleum Co., and formed the Franco Petroleum Co. under the laws of Wyoming.

Pipe-line shipments from the Salt Creek field to the Casper refineries increased from 6,000 barrels a day early in the year to double that quantity at the close, when the refining capacity at Casper had been greatly increased and included a motor spirit plant of the Standard Oil Co. of Indiana. The Burlington locomotives on the Casper division have been changed to oil burners.

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PRODUCTION.

The following table gives the production of petroleum in Wyoming from 1894 to 1913, inclusive:

Production, value, and average price per barrel of petroleum in Wyoming, 1894–1913, with the increase or decrease for each year, in barrels.

Year.	Production.	Percentage of total production.	Increase (+) or decrease (—).	Percentage of increase (+) or decrease (—).	Value.	Average yearly value per barrel.
1894	2,369				$15,920	$6.720
1895	3,455		+ 1,086	+ 45.84	27,640	8.000
1896	2,878		— 577	— 16.70	23,024	8.000
1897	3,650		+ 772	+ 26.82	29,200	8.000
1898	5,475		+ 1,825	+ 50.00	38,325	7.000
1899	5,560		+ 85	+ 1.55	38,920	7.000
1900	5,450		— 110	— 1.98	38,150	7.000
1901	5,400		— 50	— .92	37,800	7.000
1902	6,253		+ 853	+ 15.74	43,771	7.000
1903	8,960		+ 2,707	+ 40.29	62,720	7.000
1904	11,542		+ 2,582	+ 28.82	80,794	7.000
1905	8,454		— 3,088	— 26.75	51,545	6.100
1906	[a] 7,000		— 1,454	— 17.20	49,000	7.000
1907	[b] 9,339	0.005	+ 2,339	+ 33.41	21,883	2.343
1908	[b] 17,775	.01	+ 8,436	+ 90.33	27,920	1.570
1909	[b] 20,056	.01	+ 2,281	+ 12.83	34,456	1.718
1910	[b] 115,430	.05	+ 95,374	+475.54	93,536	.810
1911	[b] 186,695	.085	+ 71,265	+ 61.74	124,037	.664
1912	1,572,306	.71	+1,385,611	+742.18	798,470	.507
1913	2,406,522	.97	+ 834,216	+ 53.06	1,187,232	.493
Total	4,404,569	.14			2,824,343	.641

[a] Estimated. [b] Includes Utah.

FIELD REPORT.

The field report for Wyoming in 1912 and 1913 is shown in the following table:

Field report for Wyoming in 1912 and 1913, by counties.

WELLS.

County.	1912					1913			
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Completed.		Abandoned.	Productive Dec. 31.
		Oil.	Dry.			Oil.	Dry.		
Bighorn	16	1	6	1	16				16
Converse	5	2			7	6		4	9
Crook	11		2	1	10	2	2		12
Fremont	37	4		10	31		1	10	21
Johnson	1				1			1	
Lincoln							1		
Natrona	65	50	16	15	100	7	7	10	97
Uinta	25	2		3	24	19	5		43
Total	160	59	24	30	189	34	16	25	198

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Field report for Wyoming in 1912 and 1913, by counties—Continued.

ACREAGE.

County.	1912			1913		
	Fee.	Lease.	Total.	Fee.	Lease.	Total.
Bighorn	2,360	3,190	5,550	532	2,190	2,722
Converse	468	400	868	468	2,240	2,708
Crook	1,880	160	2,040	1,880	.....	1,880
Fremont	2,776	10,376	13,152	1,260	5,320	6,580
Johnson	160	.....	160	160	.....	160
Natrona	2,020	18,340	20,360	4,840	14,480	19,320
Uinta	10,480	12,200	22,680	9,080	11,000	20,080
Total	20,144	44,666	64,810	18,220	35,230	53,450

MISSOURI.

DEVELOPMENT.

The discovery of oil at shallow depths at Swart in Vernon County, Mo., in 1913, led to some excitement and the drilling of two shallow wells without effective results up to the close of the year. A shallow well was drilled in Adair County which yielded a showing of oil, but no production.

PRODUCTION.

The production of petroleum in Missouri from 1889 to 1913, inclusive, is given in the following table:

Production of petroleum in Missouri, 1889–1913, in barrels.

Year.	Production.	Percentage of total production.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).	Value.	Average yearly value per barrel.
1889	20	.....	.....	.....	$40	$2.00
1890	278	.....	+ 258	+1,290.00	556	2.00
1891	25	.....	− 253	− 91.01	84	3.39
1892	10	.....	− 15	− 60.00	40	4.00
1893	50	.....	+ 40	+ 400.00	154	3.08
1894	8	.....	− 42	− 84.00	40	5.00
1895	10	.....	+ 2	+ 25.00	50	5.00
1896	43	.....	+ 33	+ 330.00	185	4.30
1897	19	.....	− 24	− 55.81	174	9.16
1898	10	.....	− 9	− 47.37	105	10.50
1899	132	.....	+ 122	+1,220.00	205	1.553
1900	[a] 1,602	.....	+ 1,470	+1,113.64	1,177	.735
1901	[a] 2,335	.....	+ 733	+ 45.76	2,600	1.114
1902	[a] 757	.....	− 1,578	− 67.58	1,066	1.41
1903	[a] 3,000	.....	+ 2,243	+ 296.30	4,650	1.55
1904	[a] 2,572	.....	− 428	− 14.27	4,769	1.854
1905	[a] 3,100	.....	+ 528	+ 20.53	3,320	1.071
1906	[a] 3,500	.....	+ 400	+ 12.90	4,890	1.397
1907	[a] 4,000	.....	+ 500	+ 14.28	6,500	1.625
1908	[a] 15,246	.....	+11,246	+ 281.15	22,345	1.466
1909	[a] 5,750	.....	− 9,496	− 62.28	7,830	1.362
1910	[a] 3,615	.....	− 2,135	− 37.13	4,794	1.326
1911	[a] 7,995	.....	+ 4,380	+ 121.2	7,995	1.000
1912	[b]	.....	.....	.....	.....	.....
1913	[c] 10,843	.004	+10,843	.....	19,263	1.777
Total	64,920	.....	.....	.....	92,832	1.430

[a] Includes Michigan.
[b] No production for Missouri; Michigan included in Lima, Ohio.
[c] Includes Alaska, Michigan, and New Mexico.

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MICHIGAN.

There was the usual slight production in 1913 from the small wells in St. Clair County. In 1912 oil was struck in the city of Saginaw, Saginaw County, and the usual drilling excitement ensued. The subsequent wells were failures, and the enterprise was abandoned in 1913.

ARKANSAS.

In four counties in Arkansas five wells were drilled in 1913 in search of petroleum, but with no result except dry holes.

Nearly 600,000 acres of leases are involved in the lands where these dry holes were drilled.

NEW MEXICO.

In 1912 the old Brown well, 2½ miles northeast of Dayton, in Eddy County, which had been yielding three barrels a day, was improved by setting a packer between the oil sand and the artesian water stratum which lies 100 feet above. The well then yielded some 50 barrels of oil a day after the packer had been reset, successfully shutting off the water. In 1913 the Pecos Valley Oil & Gas Co. began drilling a test on the Martin farm, 1 mile southwest of the Brown well, in the direction of Dayton. The Belt well, due east of Dayton, was deepened and the Seven Rivers Oil Co. began drilling about 15 miles southwest of Dayton. A deep well test was also made in this same region by the Dayton Petroleum Co., headed by California capital, about three-fourths mile south of the Brown well. Five other companies secured acreage in this region and prepared to drill. About 4 miles north of Roswell a well was drilled under the encouragement of the Roswell Chamber of Commerce.

All of this development work was somewhat discouraged by the fact that by the close of the year the California interests abandoned their deep-well test. Later in the year wells were started by companies which operated one to the east and the other to the west of Carlsbad, in Eddy County.

WASHINGTON.

The wildcatting for oil which has been carried on for a year or two in the region of Forks, Clallam County, Wash., resulted in 1913 in finding small quantities of oil. This discovery, in connection with the natural seepages between Forks and the mouth of Hoh River, led to the leasing of large tracts of land, covering most of the territory between the region of Forks, Clallam County, and Moclips, in Chehalis County. Near Taholah, at the mouth of Queniult River, the Jefferson Oil Co. began the exploration of the gas indications of that region, and obtained a small quantity of oil and considerable gas at a depth of less than 350 feet. Inasmuch as the region is largely covered by the Queniult and other Indian reservations, C. T. Lupton, of the Geological Survey, made a field examination of the oil and gas prospects on the Pacific slope of the Olympic Peninsula. The investigation, which was a reconnaissance, was made by the United States Geological Survey on behalf of the Office of Indian

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Affairs and has been the subject of a report recently issued.[1] Mr. Lupton reports that the main surface showings of oil in the region are situated 15 to 20 miles north of the Queniult Reservation, near Hoh River. Two prospect holes about 18 feet in depth have been dug in this locality, one in sec. 12, T. 26 N., R. 14 W., and the other in sec. 11, T. 26 N., R. 13 W., Willamette principal meridian, about 5 miles farther east. The former is known as the Jefferson Oil Co.'s seep, and the latter as the Lacey seep.

Analyses of the samples of oil collected at these prospects by Mr. Lupton show a paraffin oil of very high grade, containing no asphaltum. Near the Jefferson Oil Co.'s prospect a well has been drilled to a depth of about 800 feet, and near Forks another well has been drilled to a depth of 1,400 feet or more. In both of these wells, the drilling of which is still in progress, some gas and traces of oil have been encountered, though they have not yet been found in sufficient quantities to be of economic importance.

Near Taholah, at the mouth of Queniult River, is a mound about 50 feet in height and 300 to 400 feet in diameter at the base, with a small opening at the apex from which gas and mud issue. This mound, which is locally known as the Garfield gas mound, has undoubtedly been built up by mud carried up by the gas and deposited around the opening. The adjacent spruce trees indicate that the mound is hundreds of years old, some trees with trunks 3 or 4 feet in diameter being located within 6 or 8 feet of the top of the mound. The gas issuing from this opening contains about 95 per cent of methane and only small amounts of nitrogen and carbon dioxide.

At a distance of 125 feet from the apex of this mound a well is now being drilled for oil, by means of a rotary outfit, the depth so far reached being about 350 feet.

Another prominent gas vent was examined by Mr. Lupton on Hoh River, about 25 miles above its mouth, near Spruce post office. At this place the gas is escaping from a funnel-shaped hole which is full of water. The vent is known locally as the Devils Mush Pot, and the gas is apparently of the same quality as that collected in Taholah.

Other places within the general region were visited, at which outcrops of sandy clay gave the odor of gas and oil, the clay having long been referred to by the Indians as "smell mud." A few anticlines, which may serve as reservoirs for oil and gas, cross the region, mainly in a northeast-southwest direction. These features are described and mapped in Mr. Lupton's report.

The seeps and the gas vents encourage a reasonable expectation that petroleum and natural gas may be present in paying quantities, but their existence in this locality can be proved only by drilling.

IMPORTS.

For many years occasional importations of crude petroleum, and, more frequently, of some special product have been received in the United States, but without any particular bearing upon the trade. The first significant imports were those of gasoline from Borneo to the Pacific coast to supply the deficiency which then existed for gasoline for the growing automobile consumption. The low price now

[1] Lupton, C. T., Oil and gas in the western part of the Olympic Peninsula, Washington: U. S. Geol. Survey Bull. 581, 59 pp., 1914.

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ruling for gasoline on the Pacific coast and the considerable supply now attainable of lighter oils, of which the supply is rapidly increasing in California, will, without doubt, stop these imports of gasoline.

In 1911 the importation of crude petroleum from Mexico began to assume significant proportions and rapidly increased in 1912 and in 1913, so that in the last year 17,869,082 barrels of crude petroleum were imported almost entirely from Mexico. This amounted to over two-thirds of the total production of petroleum in Mexico, with the probability of considerable extension of this trade from year to year.

Quantity and value of petroleum, paraffin oil, and ozokerite and paraffin wax imported for consumption into the United States, 1909–1913.

Year.	Petroleum.		Paraffin oil.		Ozokerite and paraffin wax.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Barrels.		*Barrels.*		*Pounds.*		
1909	69,614	$197,023	38,926	$79,438	10,152,913	$699,243	$975,704
1910	557,181	1,398,861	2,952	39,748	15,971,672	986,081	2,424,690
1911	1,709,932	2,410,884	4,019	43,343	12,699,459	749,475	3,203,702
1912	7,383,229	6,062,881	2,571	32,565	17,617,068	985,959	7,101,405
1913	17,869,082	12,947,280	2,676	49,458	16,051,322	932,894	13,929,632

EXPORTS.

TERRITORIAL SHIPMENTS.

Alaska.—In the following table are given the shipments of petroleum products to Alaska from 1906 to 1913, inclusive:

Shipments of petroleum products to Alaska from other parts of the United States, 1906–1913.

Year.	Crude.		Naphtha.		Illuminating.		Lubricating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Barrels.		*Gallons.*		*Gallons.*		*Gallons.*	
1906	63,526	$38,409	580,978	$100,694	568,033	$109,964	83,992	$32,854
1907	216,769	143,506	636,881	119,345	510,145	99,342	100,145	37,929
1908	283,128	176,483	939,424	147,104	566,598	102,567	94,542	36,423
1909	334,164	334,258	746,930	118,810	531,727	98,786	85,687	35,882
1910	448,468	477,673	788,154	136,569	626,972	95,483	104,512	38,625
1911	431,961	406,400	1,238,865	167,915	423,750	57,896	100,141	34,048
1912	79,144	64,866	2,736,739	344,739	672,176	100,722	154,565	60,949
1913	4,727	4,723	1,735,658	272,661	661,656	106,603	150,918	61,966

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Hawaiian Islands, Philippine Islands, and Porto Rico.—In the following table are given the shipments of petroleum products to the Hawaiian Islands, Philippine Islands, and Porto Rico from 1907 to 1913, inclusive:

Shipments of petroleum products to Hawaii, the Philippines, and Porto Rico, 1907–1913.

Year.	Crude.		Naphtha.		Illuminating.		Lubricating.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
HAWAII.	*Barrels.*		*Gallons.*		*Gallons.*		*Gallons.*	
1907	926,581	$581,905	484,435	$73,405	1,441,037	$230,968	355,451	$104,930
1908	1,136,188	802,325	648,310	91,851	1,143,991	179,507	358,262	140,157
1909	1,039,063	845,805	804,169	127,076	1,401,381	232,340	367,831	121,282
1910	1,288,502	1,061,060	974,268	160,700	1,359,671	226,481	359,528	133,968
1911	1,114,081	917,763	1,329,589	203,052	1,587,873	220,505	466,826	138,927
1912	917,838	861,080	2,501,938	343,062	1,817,718	190,939	477,012	165,993
1913	772,493	598,980	2,058,091	315,333	1,807,288	210,997	456,477	145,455
PHILIPPINES.								
1907			79,560	12,930	8,218,400	842,111	181,504	32,598
1908	109	322	140,550	21,775	9,234,263	957,284	257,800	61,571
1909	368	1,014	184,390	23,428	5,995,090	558,642	362,068	81,278
1910	320	1,098	318,070	42,058	10,643,804	862,496	432,867	96,213
1911	131	376	1,074,615	158,592	11,653,570	913,760	470,832	107,499
1912	543	476	1,326,040	216,810	12,634,519	1,094,596	487,607	121,999
1913			1,414,225	280,690	12,091,810	1,142,403	517,494	105,001
PORTO RICO.								
1907			219,691	38,003	1,700,838	176,808	223,389	53,599
1908	593	2,100	285,188	45,479	1,623,477	189,021	264,012	65,776
1909	121	340	495,367	93,649	1,931,676	216,316	218,829	78,963
1910	208	499	874,814	135,290	1,973,369	222,108	283,935	91,356
1911	1,229	2,899	1,106,327	133,470	2,323,401	207,804	479,579	117,034
1912	60	278	1,470,105	223,325	2,168,105	212,043	471,596	134,882
1913	35	117	1,580,772	303,012	2,381,187	246,137	507,412	120,007

FOREIGN SHIPMENTS.

GENERAL CONDITIONS.

Practically all forms of petroleum products, from crude oil to paraffin wax, form part of the export trade of the United States, and petroleum products in one form or another, especially kerosene, reach all parts of the world.

Between 4,000,000 and 5,000,000 barrels of crude oil are exported each year; and in 1913 about 200,000,000 gallons of gasoline and naphtha, slightly over 1,000,000,000 gallons of illuminating oil, over 200,000,000 gallons of lubricants, and over 300,000,000 gallons of gas oils, and more than 27,000,000 barrels of residuum were exported. In all, reduced to barrels, the exports amounted to 50,868,231 barrels in 1913, or 20.5 per cent of the total production.

This trade, which represents essentially the overflow of products beyond the consumptive requirements of the United States, is capable of an enormous expansion, if one considers the following interesting table recently compiled by Sir Boverton Redwood, which shows the consumption of kerosene per head of population in various countries in 1911.

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Consumption of kerosene during 1911 per head of population, by countries.

	Gallons.		Gallons.
United States	7.3	Roumania	1.8
Canada	4.0	Austria	1.8
England	3.9	Japan	1.6
Germany	3.6	Brazil	1.2
Australia	3.4	Italy	1.0
France	2.5	Mexico	.7
Russia	2.0	India	.6
South Africa	2.0	Spain	.5
Egypt	1.9	China	.4

In spite of the use of electricity and gas for illumination in the United States, the use of kerosene is shown by this table to amount to 7.3 gallons per year for every person in the United States. The quantity used in other countries is in every case less; four gallons per capita in Canada comes next to the United States, and England requires practically the same quantity.

There is a marked decline of the per capita used in other countries, and when one considers that China with its enormous population only consumes 0.4 of a gallon per capita, the quantity of kerosene which might be sold before the total Chinese consumption per capita would be brought up to the level of that of the United States would equal 11,000,000,000 gallons per annum, or ten times the quantity now exported from the United States, or about three times as much kerosene as is yielded by the total quantity of crude oil produced in the United States. In spite of our rapidly increasing production petroleum must be recognized as a limited mineral resource in the world, and the responsibilities for properly conserving the supply are evident from these considerations.

EXPORTS BY FISCAL YEARS.

In the following table is given a statement showing the foreign markets for oil in the four fiscal years ending June 30, 1913:

Exports of petroleum in its various forms from the United States for the fiscal years 1910 to 1913, by countries and kinds.

Country and kind.	Year ending June 30—			
	1910	1911	1912	1913
CRUDE.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
Europe:				
Belgium	3		54	131
France	311,607	520,092	880,808	584,092
Germany		417	275	238
Spain	230,744	276,588	224,561	307,202
United Kingdom		5	96,864	26,589
Other Europe			23,810	476
	542,354	797,102	1,226,372	918,728
North America:				
Mexico	981,019	580,913	541,728	384,260
Cuba	112,238	124,485	109,364	127,656
Dominion of Canada	933,858	1,244,306	1,817,256	2,969,525
Panama	633,283	927,572	668,688	107
Other North America	95,344	72,681	46,336	419
	2,755,732	2,949,957	3,183,372	3,481,967
South America	722,706	661,764	543,794	255,177
All other countries	731	481	1,471	2,293
Total crude	4,021,523	4,409,304	4,955,009	4,658,165

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Exports of petroleum in its various forms from the United States for the fiscal years 1910 to 1913, by countries and kinds—Continued.

Country and kind.	Year ending June 30—			
	1910	1911	1912	1913
REFINED.				
Gasoline.[a]				
Europe:	Gallons.	Gallons.	Gallons.	Gallons.
France				3,494,604
Germany				1,942,746
Netherlands				4,007,592
United Kingdom				6,049,646
Other Europe				2,048,357
				17,542,945
North America				51,932,234
South America				8,652,143
Africa				1,614,794
Asia and Oceania				1,956,801
Total gasoline				81,698,917
Naphtha.				
Europe:				
France	6,583,437	8,570,396	25,626,916	16,491,593
Germany	11,394,253	7,668,059	15,317,517	12,926,229
Sweden	522,680	702,010	1,283,881	1,471,525
United Kingdom	16,924,159	28,332,440	26,820,738	13,426,820
Other Europe	12,419,372	20,487,537	30,877,612	22,046,570
	47,843,901	65,760,442	99,926,664	66,362,737
North America	17,320,657	24,173,133	35,213,601	4,118,900
West Indies	320,160	539,065	856,510	265,424
South America	5,785,161	11,047,387	18,933,132	15,360,440
Asia and Oceania	5,210,862	8,339,291	13,707,125	11,766,558
Africa	1,170,182	2,138,942	2,403,118	3,947,513
	29,807,022	46,237,818	71,113,486	35,458,835
Total naphtha	77,650,923	111,998,260	171,040,150	101,821,572
Illuminating.				
Europe:				
Belgium	41,287,412	51,104,876	47,032,277	58,881,411
Denmark	20,238,497	23,494,758	29,966,403	30,104,209
France	46,924,343	45,322,037	37,702,251	52,953,474
Germany	151,890,625	106,405,766	92,289,677	103,963,882
Italy	26,057,918	23,915,541	30,469,655	21,182,834
Netherlands	121,808,987	102,904,032	112,747,606	134,204,916
Sweden and Norway	37,187,417	42,055,097	39,681,488	43,376,319
United Kingdom	194,226,610	164,599,961	166,215,650	169,283,659
Portugal	5,751,226	3,958,728	6,710,191	6,640,313
Other Europe	4,191,054	3,952,915	7,180,070	5,533,149
	649,564,089	568,804,509	569,995,268	626,249,166
North America:				
British North America	10,201,902	11,257,460	15,605,516	18,226,258
Central America	2,590,238	3,413,245	2,494,184	4,086,746
Mexico	740,615	200,252	165,396	1,225,289
West Indies—				
British	3,002,377	3,164,058	3,538,767	3,184,152
Other	3,447,741	4,031,921	2,960,860	5,318,112
Other North America	669,073	836,597	911,203	1,004,131
	20,651,946	22,903,533	25,675,926	33,044,688
South America:				
Argentina	18,490,512	15,723,182	28,449,374	21,367,616
Brazil	29,874,870	30,846,695	37,491,101	32,828,176
Chile	8,059,982	7,123,137	7,361,898	7,961,224
Uruguay	7,009,158	6,140,675	6,675,489	8,561,419
Venezuela	1,444,847	1,449,897	1,511,255	1,552,294
Other South America	3,546,848	3,270,171	2,961,441	2,790,195
	68,426,217	64,553,757	84,450,558	75,060,924

[a] Included with naphtha prior to 1913.

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Exports of petroleum in its various forms from the United States for the fiscal years 1910 to 1913, by countries and kinds—Continued.

Country and kind.	Year ending June 30—			
	1910	1911	1912	1913
REFINED—continued.				
Illuminating—Continued.				
Asia:	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
Chinese Empire	65,817,980	107,167,449	68,164,997	79,015,610
Hongkong	12,692,037	12,074,776	14,794,710	7,767,090
East Indies—				
British	37,545,823	51,735,360	57,390,564	36,171,967
Dutch	12,572,121	19,235,260	14,370,190	13,417,993
Other East Indies	4,707,640	6,185,050	7,246,805	4,700,340
Japan	58,067,925	57,750,354	109,215,587	85,399,913
Other Asia	11,596,113	19,887,195	15,101,190	22,891,700
	202,999,639	274,035,444	286,284,043	249,364,313
Oceania:				
British	26,452,025	29,478,944	32,077,747	25,635,287
Philippine Islands	6,265,167	9,887,437	14,054,707	13,073,752
Other Oceania	10,880	17,084	18,417	44,904
	32,728,072	39,383,465	46,150,871	38,753,943
British Africa	18,135,570	16,604,729	14,961,057	14,449,160
Other Africa	12,522,003	36,025,605	16,532,125	11,972,103
	30,657,573	52,630,334	31,493,182	26,421,263
Total illuminating	1,005,027,536	1,022,311,042	1,044,049,848	1,048,894,297
Lubricating.				
Europe:				
Belgium	10,671,107	10,229,815	11,806,155	13,782,639
France	20,653,620	19,449,734	25,575,537	26,136,545
Germany	20,533,022	20,450,031	24,306,176	26,418,269
Italy	7,606,839	8,323,598	9,283,969	7,637,394
Netherlands	9,571,203	10,488,285	11,396,618	12,174,926
United Kingdom	54,748,606	53,573,129	62,886,561	61,412,394
Other Europe	7,966,759	9,026,568	11,189,030	13,243,346
	131,771,158	131,541,160	156,446,046	160,805,513
North America	6,095,575	7,064,255	7,587,478	9,846,385
West Indies	1,390,979	1,505,270	1,717,456	1,881,707
South America	7,494,903	7,843,115	10,162,069	11,504,006
Asia and Oceania	17,047,643	18,752,639	20,859,871	23,248,022
Africa	6,640,019	6,936,056	5,352,277	6,385,866
	38,659,119	42,101,335	45,679,151	52,865,986
Total lubricating	170,430,277	173,642,495	202,125,197	213,671,499
Gas and fuel oil.[a]				
Europe	.....	.....	.....	152,327,287
North America	.....	.....	.....	100,101,349
South America	.....	.....	.....	66,883,260
Oceania	.....	.....	.....	38,213
Africa	.....	.....	.....	1,179,716
Total gas and fuel	.....	.....	.....	320,529,925
Residuum.				
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*
Europe	112,792,362	102,430,883	111,321,764	146,037
North America	10,742,492	15,708,381	30,443,892	2,169,607
All other countries	520,409	5,258,924	26,573,822	25,197,924
Total residuum	124,055,263	123,398,188	168,339,478	27,513,568

[a] Included with residuum prior to 1913.

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EXPORTS BY CALENDAR YEARS.

The following tables, compiled by the Bureau of Foreign and Domestic Commerce of the Department of Commerce, show the quantity and value of petroleum and its products (mineral oils) exported from ports and districts in the United States for the years ending December 31, 1912 and 1913:

Exports of mineral oils from the United States in the calendar years 1912 and 1913, by kind and port.

Kind and port.	1912		1913	
	Quantity.	Value.	Quantity.	Value.
CRUDE.	*Barrels.*		*Barrels.*	
New York	970,926	$2,399,698	1,174,017	$3,957,755
Philadelphia	87	138	6	38
Galveston	381	480	495	1,503
Other districts	3,521,785	4,370,168	3,455,712	4,488,998
Total	4,493,129	6,770,484	4,630,230	8,448,294
NAPHTHA.	*Gallons.*		*Gallons.*	
Baltimore	40,274	5,843	62,965	11,617
Boston and Charlestown	80,648	11,721	44,381	8,585
New York	105,423,206	11,933,874	102,869,333	16,872,213
Philadelphia	16,999,114	1,853,716	23,053,365	3,348,437
Galveston	30,485	3,273	35,911	5,346
Other districts	63,426,367	6,650,961	61,977,424	7,845,410
Total	186,000,094	20,459,378	188,043,379	28,091,608
ILLUMINATING.				
Baltimore	64,762	5,489	139,282	14,199
Boston and Charlestown	162,801	15,994	108,963	11,668
New York	566,796,456	37,834,220	538,619,277	40,100,916
Philadelphia	257,075,383	14,099,765	229,282,278	13,890,288
Galveston			165	20
Other districts	202,038,837	10,128,554	351,291,278	18,025,016
Total	1,026,138,239	62,084,022	1,119,441,243	72,042,107
LUBRICATING AND PARAFFIN.				
Baltimore	11,753,631	1,445,574	12,115,947	1,648,470
Boston and Charlestown	105,537	19,776	94,506	18,972
New York	144,934,778	19,657,690	138,778,365	20,227,289
Philadelphia	47,255,283	5,348,763	43,095,432	5,243,542
Galveston	679,010	137,002	552,276	114,154
Other districts	11,664,967	1,688,662	13,002,566	2,356,122
Total	216,393,206	28,297,467	207,639,092	29,608,549
RESIDUUM.				
Baltimore	21,801	1,740		
Boston and Charlestown	159,557	9,988	2,505	263
New York	51,578,976	1,621,150	37,109,808	1,428,062
Philadelphia	32,425,634	671,617	20,220,194	742,123
Galveston	270	41	252	72
Other districts	182,050,400	4,294,495	369,539,614	8,955,331
Total	266,236,938	6,599,031	426,872,373	11,125,851
Grand total	1,883,479,897	124,210,382	2,136,465,721	149,316,409

RECAPITULATION BY KINDS.

Crude.....gallons.	188,711,420	$6,770,484	194,469,634	$8,448,294
Naphtha.....do....	186,000,094	20,459,378	188,043,379	28,091,608
Illuminating.....do....	1,026,138,239	62,084,022	1,119,441,243	72,042,107
Lubricating and paraffin.....do....	216,393,206	28,297,467	207,639,092	29,608,549
Residuum.....do....	266,236,938	6,599,031	426,872,373	11,125,851
Total	1,883,479,897	124,210,382	2,136,465,721	149,316,409

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Exports of mineral oils from the United States in the calendar years 1912 and 1913, by kind and port—Continued.

RECAPITULATION BY PORTS, IN GALLONS.

Kind and port.	1912		1913	
	Quantity.	Value.	Quantity.	Value.
CRUDE.	*Barrels.*		*Barrels.*	
Baltimore	11,880,468	$1,458,646	12,318,194	$1,674,286
Boston and Charlestown	508,543	57,479	250,355	39,488
New York	909,512,304	73,446,632	866,685,489	82,586,235
Philadelphia	353,757,246	21,973,999	315,651,519	23,224,428
Galveston	725,765	140,796	609,374	121,095
Other districts	607,095,571	27,132,830	940,950,790	41,670,877
Total	1,883,479,897	124,210,382	2,136,465,721	149,316,409

Exports of mineral oils from the United States in 1912 and 1913, by months, in gallons.

Month.	1912		1913	
	Quantity.	Value.	Quantity.	Value.
January	132,160,209	$7,901,126	168,170,286	$11,176,786
February	110,618,086	6,864,317	129,026,557	9,650,639
March	122,254,481	8,037,125	148,935,705	10,854,484
April	163,206,438	10,619,283	171,498,655	13,152,384
May	195,734,654	13,171,378	174,851,170	12,786,745
June	147,859,275	10,573,193	185,643,586	12,574,364
July	186,196,374	11,973,785	176,685,335	12,520,886
August	166,618,226	11,677,902	182,584,132	12,482,146
September	182,896,451	12,235,747	191,555,641	13,277,685
October	148,863,918	9,538,976	219,474,668	15,147,538
November	181,012,206	11,882,373	171,537,378	11,887,420
December	146,059,579	9,793,377	216,502,608	13,805,332
Total	1,883,479,897	124,210,382	2,136,465,721	149,316,409

The following tables, furnished by the Bureau of Foreign and Domestic Commerce, Department of Commerce, give the exports of crude petroleum and its products from Texas, by months and kinds and by customs districts during 1912 and 1913:

Exports to foreign countries of crude and refined petroleum from all ports of Texas in calendar year 1912, by months.

Month.	Crude.			Naphtha.		Illuminating.	
	Quantity.		Value.	Quantity.	Value.	Quantity.	Value.
	Barrels.	*Gallons.*		*Gallons.*		*Gallons.*	
January	14,825	622,691	$15,101	1,097,921	$133,104	7,522,107	$443,654
February	322	13,500	270	171,246	28,174	5,536,320	337,417
March	4	150	8	9,348	1,045	6,915,316	336,275
April	5,706	239,720	20,365	995,048	70,977	2,714,857	190,429
May	39,670	1,666,139	54,157	2,250,321	165,564	13,102,353	708,009
June	2,478	104,076	2,304	1,114,595	103,684	9,362,613	503,347
July	8	350	14	7,545	996	5,577,996	270,641
August	320	13,458	269	1,865,764	174,940	6,887,311	421,475
September	381	16,000	480	69,035	10,716	3,787,339	238,648
October	22,618	949,939	34,647	155,100	12,663	3,885,041	189,799
November				103,021	16,415	2,682,067	188,436
December	476	20,000	950	650,991	103,381	4,919,090	307,577
Total	86,810	3,646,023	128,565	8,499,935	821,659	72,892,410	4,105,707

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Exports to foreign countries of crude and refined petroleum from all ports of Texas in calendar year 1912, by months—Continued.

Month.	Lubricating and paraffin.		Residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
January	72,689	$15,264	2,947,512	$99,061	12,262,920	$706,184
February	90,115	18,103	2,874,936	106,493	8,686,117	490,457
March	83,920	16,064	2,696,108	94,404	9,704,342	447,796
April	91,675	18,619	3,675,459	127,118	7,716,759	427,508
May	102,550	21,368	5,500,776	192,527	22,622,139	1,141,625
June	105,846	21,693	3,197,470	109,055	13,884,800	740,083
July	105,019	20,721	6,811,539	231,173	12,502,449	523,545
August	119,107	24,357	3,524,452	122,060	12,410,092	743,101
September	209,196	41,710	6,972,043	233,994	11,053,513	525,548
October	140,546	28,036	4,548,133	143,586	9,688,759	378,731
November	88,316	18,782	5,926,507	192,214	8,799,911	415,847
December	78,512	15,201	8,061,966	268,834	13,730,559	695,943
Total	1,287,491	259,918	56,736,901	1,920,519	143,062,760	7,236,368

Exports to foreign countries of crude and refined petroleum from all ports of Texas in calendar year 1913, by months.

Month.	Crude.			Naphtha.		Illuminating.	
	Quantity.		Value.	Quantity.	Value.	Quantity.	Value.
	Barrels.	*Gallons.*		*Gallons.*		*Gallons.*	
January	17	730	$30	2,791	$437	4,602,255	$220,543
February	21,872	918,656	32,057	2,112,992	178,202	4,597,760	290,373
March	.....	.....	.....	2,077	279	4,011,913	185,700
April	.....	.....	.....	2,273,505	232,742	11,048,049	719,760
May	4,512	189,510	16,264	2,067,508	195,044	9,586,779	568,817
June	.....	.....	.....	475,075	116,180	15,680,497	935,074
July	19	806	29	302,445	42,273	11,838,645	874,044
August	3,877	162,878	15,478	2,092,477	240,398	14,930,530	788,680
September	18,787	789,061	18,908	57,514	9,458	7,163,617	422,400
October	27	1,145	42	728,631	55,422	13,702,416	732,398
November	79,121	3,323,120	117,478	238,956	17,184	11,869,053	667,231
December	444	18,479	427	623,222	99,320	12,529,774	666,938
Total	128,676	5,404,385	200,713	10,977,193	1,186,939	121,651,288	7,071,958

Month.	Lubricating and paraffin.		Residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
January	54,916	$10,506	8,107,199	$276,571	12,857,891	$508,087
February	132,820	27,328	4,353,404	154,865	12,115,632	682,825
March	40,234	7,435	7,285,601	246,283	11,339,825	439,697
April	111,551	23,090	3,570,363	124,962	17,003,468	1,100,554
May	54,009	11,089	7,958,931	266,266	19,856,737	1,057,490
June	396,467	79,789	10,963,638	391,176	27,515,677	1,522,219
July	2,749	795	9,178,753	312,925	21,323,398	1,230,066
August	168,617	33,809	11,350,660	369,235	28,705,162	1,447,600
September	47,663	9,720	8,247,131	286,940	16,304,986	747,426
October	142,510	28,295	10,953,119	357,261	25,527,821	1,173,418
November	17,771	4,279	7,918,435	261,329	23,367,335	1,067,501
December	212,193	45,584	12,570,033	424,959	25,953,701	1,237,228
Total	1,381,500	281,719	102,457,267	3,472,772	241,871,633	12,214,101

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Exports of crude and refined petroleum from Texas, by customs districts, in calendar year 1912.

Customs district.	Crude, including all natural oils.			Naphtha.		Illuminating.	
	Quantity.		Value.	Quantity.	Value.	Quantity.	Value.
	Barrels.	*Gallons.*		*Gallons.*		*Gallons.*	
Corpus Christi	853	35,825	$1,193	28,178	$2,752	34	$2
Brazos de Santiago				3,534	630	393	40
Galveston	381	16,000	480	30,485	3,273		
Sabine	85,573	3,594,048	126,884	8,382,773	807,496	72,821,829	4,095,861
Paso del Norte	3	150	8	47,643	6,393	46,791	5,454
Saluria				7,322	1,115	23,363	4,350
Total	86,810	3,646,023	128,565	8,499,935	821,659	72,892,410	4,105,707

Customs district.	Lubricating and heavy paraffin.		Residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
Corpus Christi	72,990	$9,569	38,702	$1,004	175,729	$14,520
Brazos de Santiago	4,565	1,598			8,492	2,268
Galveston	679,010	137,002	270	41	726,765	140,796
Sabine	415,986	82,903	56,693,479	1,919,061	141,908,115	7,032,225
Paso del Norte	18,761	5,836			113,345	17,691
Saluria	96,179	23,010	4,450	393	131,314	28,858
Total	1,287,491	259,918	56,736,901	1,920,519	143,062,760	7,236,368

Exports of crude and refined petroleum from Texas, by customs districts, in calendar year 1913.

Customs district.	Crude, including all natural oils.			Naphtha.		Illuminating.	
	Quantity.		Value.	Quantity.	Value.	Quantity.	Value.
	Barrels.	*Gallons.*		*Gallons.*		*Gallons.*	
Laredo	203	8,513	$324	6,041	$994	17,927	$1,659
Galveston	494	20,770	1,503	35,911	5,346	165	20
Sabine	127,464	5,353,482	198,269	10,893,581	1,171,952	121,555,683	7,056,324
El Paso				19,825	3,959	23,249	2,604
Eagle Pass	515	21,620	617	21,835	4,688	54,264	11,351
Total	128,676	5,404,385	200,713	10,977,193	1,186,939	121,651,288	7,071,958

Customs district.	Lubricating and heavy paraffin.		Residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
Laredo	22,480	$3,233	247	$50	55,208	$6,260
Galveston	552,276	114,154	252	72	609,374	121,095
Sabine	773,481	156,528	102,456,668	3,472,633	241,032,895	12,055,706
El Paso	11,228	2,807			54,302	9,370
Eagle Pass	22,035	4,997	100	17	119,854	21,670
Total	1,381,500	281,719	102,457,267	3,472,772	241,871,633	12,214,101

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Exports of crude petroleum, including shipments to noncontiguous territories, from Pacific ports, 1911–1913, in barrels.

Customs district.	1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
From—						
Alaska	16	$66				
Southern California	116,056	98,301	209,374	$181,024	294,327	$230,713
Washington	363,829	374,318	985,244	1,043,653	1,475,823	1,281,185
Oregon					2	3
San Francisco	2,882,714	2,110,692	1,213,988	996,789	580,164	445,494
Total	3,362,615	2,583,377	2,408,606	2,221,466	2,350,316	1,957,395
To—						
Alaska	431,961	406,400	79,144	64,866	4,727	4,723
Canada	366,934	373,114	973,170	1,030,508	1,471,098	1,276,465
Chile	463,190	292,200	144,008	86,405	98,000	73,500
Guatemala	26,000	15,600	45,000	27,000		
Hawaii	1,114,085	917,763	917,238	861,080	772,493	598,980
Mexico	14,062	11,467	10,874	8,424	3,827	3,213
Panama	874,640	524,784	239,000	142,800		
Peru	71,436	41,367				
Salvador	111	240	42	49	12	12
Other	196	442	135	334	159	502
Total	3,362,615	2,583,377	2,408,606	2,221,466	2,350,316	1,957,395

The following table exhibits the total production of petroleum from 1904 to 1913, in barrels and in gallons, also the separate derivatives exported and their value, together with their sum and value:

Quantity of petroleum produced in, and quantities and values of petroleum products exported from, the United States during each of the calendar years from 1904 to 1913, inclusive, in gallons.

Year.	Production.		Exports.			
	Barrels of 42 gallons.	Gallons.	Mineral, crude (including all natural oils, without regard to gravity).		Mineral, refined, or manufactured. Naphtha, benzine, gasoline, etc.	
			Quantity.	*Value.*	*Quantity.*	*Value.*
1904	117,080,960	4,917,400,320	111,176,476	$6,350,652	24,989,422	$2,321,714
1905	134,717,580	5,658,138,360	126,185,187	6,085,592	28,419,930	2,214,609
1906	126,493,936	5,312,745,312	148,045,315	7,731,226	27,544,939	2,488,401
1907	166,095,335	6,976,004,070	126,306,549	6,333,715	34,625,525	3,676,206
1908	178,527,355	7,498,148,910	149,190,017	6,519,849	43,887,044	4,542,551
1909	183,170,874	7,693,176,708	170,337,773	6,027,588	68,758,675	5,799,994
1910	209,559,248	8,801,404,416	130,111,166	5,404,253	100,695,382	8,407,102
1911	220,449,391	9,258,874,422	201,843,355	6,165,403	137,294,606	11,482,761
1912	222,935,044	9,363,271,848	188,711,420	6,770,484	186,000,094	20,459,378
1913	248,446,230	10,434,741,660	194,469,634	8,448,294	188,057,107	28,092,580

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Quantity of petroleum produced in, and quantities and values of petroleum products exported from, the United States during each of the calendar years from 1904 to 1913, inclusive, in gallons—Continued.

Year.	Exports.							
	Mineral, refined or manufactured.				Residuum (tar, pitch, and all other, from which the light bodies have been distilled).		Total exports.	
	Illuminating.		Lubricating (heavy paraffin, etc.).					
	Quantity.	*Value.*	*Quantity.*	*Value.*	*Quantity.*	*Value.*	*Quantity.*	*Value.*
1904...	761,358,155	$58,384,273	89,688,123	$12,393,382	34,904,100	$1,174,156	1,022,116,276	$80,624,207
1905...	881,450,388	54,900,649	113,730,205	14,312,383	70,727,877	2,127,696	1,220,513,587	79,640,929
1906...	878,274,104	54,858,312	151,268,522	18,689,622	64,644,765	1,971,305	1,269,777,645	85,738,866
1907...	905,924,206	59,635,208	152,028,855	19,210,353	75,774,754	2,527,582	1,294,659,979	91,383,064
1908...	1,129,004,833	75,988,256	147,769,024	18,971,436	77,551,683	2,793,363	1,547,402,601	108,815,455
1909...	1,046,401,072	67,814,406	161,639,609	20,016,107	121,966,249	4,180,495	1,569,103,378	103,838,590
1910...	940,247,039	55,642,368	163,832,544	20,921,103	117,605,802	3,732,196	1,502,491,933	94,107,022
1911...	1,112,295,006	61,055,095	183,319,645	23,337,126	133,979,087	3,882,463	1,768,731,699	105,922,848
1912...	1,026,138,239	62,084,022	216,393,206	28,207,467	266,236,938	6,599,031	1,883,479,897	124,210,382
1913...	1,119,441,243	72,042,107	207,639,092	29,608,549	426,858,645	11,124,879	2,136,465,721	149,316,409

PRICES.

The exports of kerosene given in the preceding tables are the dominant factor in the fluctuation of New York and Philadelphia prices for that product. The following quotations obtained from New York trade journals are therefore for oil with a flash of 70° C., by Abel closed cup, that is, for the principal brand for export. The rise in price was continuous in 1913.

Weekly prices of refined petroleum in the United States in 1913 at New York, in cents per gallon.

Week ending—	Refined oil.			Week ending—	Refined oil.		
	Bulk.	Cases.	Barrels.		Bulk.	Cases.	Barrels.
Jan. 4	4.80	10.80	8.50	July 12	5.00	11.00	8.70
11	4.80	10.80	8.50	19	5.00	11.00	8.70
18	4.80	10.80	8.50	26	5.00	11.00	8.70
25	4.80	10.80	8.50	Aug. 2	5.00	11.00	8.70
Feb. 1	4.80	10.80	8.50	9	5.00	11.00	8.70
8	4.80	10.80	8.50	16	5.00	11.00	8.70
15	4.80	10.80	8.50	23	5.00	11.00	8.70
22	4.80	10.80	8.50	30	5.00	11.00	8.70
Mar. 1	4.80	10.80	8.50	Sept. 6	5.00	11.00	8.70
8	4.80	10.80	8.50	13	5.00	11.00	8.70
15	4.80	10.80	8.50	20	5.00	11.00	8.70
22	4.80	10.80	8.50	27	5.00	11.00	8.70
29	4.80	10.80	8.50	Oct. 4	5.00	11.00	8.70
Apr. 5	4.80	10.80	8.50	11	5.00	11.00	8.70
12	4.80	10.80	8.50	18	5.00	11.00	8.70
19	4.80	10.80	8.50	25	5.25	11.75	8.75
26	4.80	10.80	8.50	Nov. 1	5.25	11.75	8.75
May 3	4.80	10.80	8.50	8	5.25	11.75	8.75
10	4.80	10.80	8.50	15	5.25	11.75	8.75
17	5.00	11.00	8.70	22	5.25	11.75	8.75
24	5.00	11.00	8.70	29	5.25	11.75	8.75
June 7	5.00	11.00	8.70	Dec. 6	5.25	11.75	8.75
14	5.00	11.00	8.70	13	5.25	11.75	8.75
21	5.00	11.00	8.70	20	5.25	11.75	8.75
28	5.00	11.00	8.70	27	5.25	11.75	8.75
July 5	5.00	11.00	8.70				

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Wholesale prices of refined petroleum at New York at the first of each month, 1909–1913.

Month.	1909			1910			1911			1912			1913		
	Date.	Cents per gallon.		Date.	Cents per gallon.		Date.	Cents per gallon.		Date.	Cents per gallon.		Date.	Cents per gallon.	
		In barrels.	In cases.		In barrels.	In cases.		In barrels.	In cases.		In barrels.	In cases.		In barrels.	In cases.
January	2	8.50	10.90	1	8.05	10.45	7	7.40	8.90	6	7.50	9.00	4	8.50	10.80
February	6	8.50	10.90	5	7.90	10.30	4	7.40	8.90	3	8.10	9.90	1	8.50	10.80
March	6	8.50	10.90	5	7.90	10.30	4	7.40	8.90	2	8.10	9.90	1	8.50	10.80
April	3	8.50	10.90	2	7.90	10.30	1	7.40	8.90	6	8.20	10.10	5	8.50	10.80
May	1	8.50	10.90	7	7.75	10.15	6	7.25	8.75	4	8.60	10.50	3	8.50	10.80
June	5	8.50	10.90	4	7.75	10.15	3	7.25	8.75	1	8.60	10.50	7	8.70	11.00
July	3	8.40	10.80	2	7.65	10.05	1	7.25	8.75	6	8.60	10.50	5	8.70	11.00
August	7	8.25	10.65	6	7.65	10.05	5	7.25	8.75	3	8.35	10.25	2	8.70	11.00
September	4	8.25	10.65	3	7.50	9.90	2	7.25	8.75	7	8.35	10.25	6	8.70	11.00
October	2	8.25	10.65	1	7.50	9.90	7	7.35	8.85	5	8.35	10.25	4	8.70	11.00
November	6	8.15	10.55	5	7.40	8.90	4	7.35	8.85	2	8.35	10.25	1	8.75	11.75
December	4	8.05	10.45	3	7.40	8.90	2	7.35	8.85	7	8.50	10.40	6	8.75	11.75

Monthly average prices, in cents per gallon, of petroleum exported from the United States in bulk, 1910–1913.

Month.	1910		1911		1912		1913	
	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.	Crude.	Refined, illuminating.
January	2.9	6.5	3.1	5.3	3.3	5.6	4.3	6.3
February	2.7	6.0	3.5	5.3	2.5	5.6	3.0	6.4
March	2.7	5.9	2.4	5.6	3.2	5.9	3.9	6.2
April	3.4	6.1	2.8	5.5	3.7	5.9	3.6	7.0
May	3.0	6.1	2.8	5.6	4.0	6.4	4.2	6.7
June	3.6	6.0	3.1	5.4	3.6	6.4	4.4	6.8
July	2.5	6.3	2.8	5.4	3.3	6.2	4.7	6.6
August	2.3	6.1	3.2	5.6	3.4	6.2	4.7	6.2
September	3.4	5.9	2.4	5.4	3.9	6.3	4.8	6.1
October	3.0	5.7	3.6	5.5	3.7	5.9	4.4	6.3
November	3.2	5.0	3.9	5.7	4.1	5.8	4.8	6.6
December	2.9	5.5	3.2	5.4	4.0	6.0	5.1	6.3

FOREIGN OIL FIELDS.

CANADA.

PRODUCTION.

The reports of the Canada Geological Survey show that the decline in production, which has been notable since 1907, continued during 1913, from both the oil wells in Ontario and the newer developments in New Brunswick.

In the following table is given the total production of petroleum in Canada from 1904 to 1913, inclusive, as reported by the Canada Geological Survey:

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Production of petroleum in Canada, 1904–1913.

Year.	Quantity.	Value.	Average price per barrel.
	Barrels.a		
1904	552,575	$984,310	$1.780
1905	634,095	856,028	1.350
1906	569,753	761,760	1.337
1907	788,872	1,057,093	1.340
1908	527,987	747,102	1.415
1909	420,755	559,604	1.330
1910	315,895	388,550	1.230
1911	291,096	357,073	1.227
1912	243,336	345,050	1.418
1913	228,090	406,439	1.782

a Barrels of 35 imperial gallons. The Canadian barrel of 35 imperial gallons is the practical equivalent of the United States barrel of 42 gallons, the difference being less than 0.03 per cent.

Production of petroleum in Ontario and New Brunswick, 1909–1913, by districts, in barrels.

District.	1909	1910	1911	1912	1913
Bothwell	38,092	36,998	35,244	34,486	34,349
Dutton	9,513	7,752	6,732	4,335	4,610
Lambton	243,123	205,456	184,450	150,272	155,747
Leamington	5,929	141	13,501	7,115	4,172
Onondaga (Brant County)		1,005			
Tilbury and Romney	124,003	63,058	48,708	44,727	26,824
Belle River					464
Total Ontario	420,660	314,410	288,635	240,935	226,166
New Brunswick	95	1,485	2,461	2,679	2,111
Total Canada	420,755	315,895	291,096	243,614	228,277

PRICES.

The average monthly prices per barrel from 1909 to 1913, inclusive, are given in the following table:

Average monthly prices per barrel for crude oil at Petrolia, 1909–1913.

Month.	1909	1910	1911	1912	1913	Month.	1909	1910	1911	1912	1913
January	$1.44	$1.24	$1.22	$1.26	$1.681	August	$1.26	$1.22	$1.22	$1.44	$1.790
February	1.44	1.24	1.22	1.35	1.738	September	1.26	1.22	1.24	1.44	1.790
March	1.44	1.24	1.22	1.38	1.761	October	1.25	1.22	1.24	1.44	1.790
April	1.44	1.24	1.22	1.38	1.780	November	1.24	1.22	1.24	1.48	1.831
May	1.36	1.24	1.22	1.40	1.790	December	1.24	1.22	1.24	1.59	1.856
June	1.33	1.23	1.22	1.42	1.790						
July	1.27	1.22	1.23	1.42	1.790	The year	1.33	1.23	1.22	1.42	1.782

WESTERN CANADIAN PROVINCES.

Vigorous efforts were made in 1913 to develop petroleum and natural gas in the western Provinces of Canada.

MANITOBA.

In Manitoba considerable exploration was made for petroleum and natural gas in Pembina valley, 9 miles south of Manitoba, but sufficient time has not elapsed for reports of definite results. In Saskatchewan drilling was commenced in August, 1911, and by the

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end of 1913 the well was 1,600 feet deep and no flow of oil or gas had been struck, though the hole passed through shale which showed gas and also contained salt water. A dark oil-bearing shale 14 feet thick was noted. At 300 feet a flow of pure water showing 100 pounds pressure was struck.

ALBERTA.

The successful development of large supplies of natural gas at Medicine Hat and Bow Island has been described in previous reports of this series.

Recent reports on the oil developments of this region have been made by the Canada Geological Survey, and a comprehensive report of the entire Canadian oil fields is being prepared by the Canada Bureau of Mines under the authorship of F. G. Clapp, of Pittsburgh. In brief, these reports show that north of Athabasca Landing in Alberta the oil from the Dakota limestones has saturated the overlying sandstones over an area of many square miles. The limestones dip to the south and at Calgary would probably not be reached at a depth less than 5,000 feet. To the west, between the line connecting Calgary and Edmonton and the outcrop of the probable oil-bearing formations to the west, there is a narrow belt in which many small occurrences of oil will probably be noted in the minor anticlines, which are clearly observable throughout the region.

In October, 1913, a small quantity of oil having a gravity of 64° Baumé, consisting largely of gasoline, and accompanied by considerable natural gas, was noted in a well drilled about 27 miles southwest of Calgary, known as the Dingman well. This discovery created a great rush for oil property. In order to keep it within reasonable bounds a circular was signed by Mayor H. A. Sinnott, of Calgary, by J. W. Campbell for the board of trade, and by O. G. Devenish for the industrial bureau to the following effect:

> Attention having been directed from many parts of the world to the reported discovery of crude petroleum in the vicinity of Calgary, it seems expedient that some announcement should be made on the subject with the purpose of preventing any false or harmful statements being circulated with respect to the result of the oil-boring operations in this territory.
>
> After several months of boring, crude petroleum of a limited quantity was struck on October 7, at a depth of 1,562 feet in the Dingman well upon the property of the Calgary Petroleum Products Co. (Ltd.), located in sec. 6, T. 20, R. 2, west of the fifth meridian.
>
> Boring continued with some promise of ultimate success; but until oil has been struck in volume, the public is warned against placing too great confidence in circulated reports and is particularly urged to exercise care in investments in oil leases or in syndicates which may have been formed for oil exploitations.

In spite of such warnings practically all of the territory for many miles around this well has been leased and many companies have been formed, several of which are drilling.

In the hope of a more generous yield, the well was continued and at 2,700 feet still more oil of the same character was found in quantity sufficient to fill the hole for a distance of a thousand feet or more. In spite of the warnings issued by the Canadian authorities and the indications of a small yield given by the character of the oil, the hysterical speculative features of the old times have been repeated in the Calgary field, although the Canada Geological Survey has repeatedly warned the public against overconfidence in the field and especially against investment in the stock companies depending

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upon public subscription. The Port Arthur News, commenting on the new oil discoveries in Alberta Province, gives the following timely advice:

> Financial journals that have investigated the oil-producing opportunities in Alberta are outspoken in their warnings to the public against investing real money in ventures that have yet to be proved worth while. Particularly it is urged on behalf of the little fellow, the man on salary, to keep out of oil speculations whose promoters offer to sell stock at a few cents per share.
>
> In the case of Alberta it is claimed by some writers that even if the bubble turned out to be substantially productive of oil, not one quarter of the companies with stock for sale could expect to yield their stockholders a cent's worth of profit in return for the risks they have taken.

It may be reasonably expected that with this great excitement, after the usual disappointments and the many unreasonable high hopes, the region will settle down as a small field of high-grade oil. In the meantime, the prospects for greater yields are good in the Athabasca territory.

Drilling excitement has also extended to British Columbia, where in the Pitt River valley many wells drilled years ago and abandoned are being reopened, and there is prospect of a yield of oil where the territory is not too broken. According to Consul General R. E. Mansfield, of Vancouver, a company composed of Vancouver citizens, which has been drilling for some time in the Pitt River region, recently found a limited flow of oil which was abandoned because of a strong flow of water in two wells. Drilling is continued. Wells will also be drilled in the Revelstoke region.

MEXICO.

Development work in Mexico was remarkably active during 1913, considering the unsettled conditions of the country. It resulted in the development of several large wells distributed over such a wide extent of territory as to assure a permanent large supply of oil. Up to the present time the supply of oil from Mexico has been furnished by a very few wells of phenomenally large size. One of these, owned by American interests, has furnished over 30,000,000 barrels of oil, and another, of English ownership, has furnished almost as great a quantity. Development of other large gushers, not only in the neighborhood of those referred to above but at considerable distance, and active prospecting has given evidence of the intention on the part of the principal producers to develop the fields rapidly. The prospect is that a very large trade in fuel oil will be developed not only in Europe but along the east coast of the United States and will make use of the fleet of about 40 large tank steamers which will soon be available. The market which can easily be supplied by this fleet of tank steamers is sufficiently great to justify a large increase in the production of Mexican oil without decrease in the price. Rather, it is probable that the price of Mexican oil will increase as the trade becomes firmly established. The pipe-line systems connected with the Mexican oil fields were extended during the year, and the fact that several oil companies began erection of refineries near Tampico evinces the general policy of sending out products rather than crude oil. The number of companies approaching the stage of actual production of oil is increasing rapidly. There are now 160 companies engaged in actual exploration of the Mexican field, although not all are actual producers.

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A very comprehensive history of the Mexican oil field was published in the leading oil journals by E. De Golyer at the close of 1913. A complete list of the oil companies in the Mexican fields, including lists of their directors, is given in the Mexican Yearbook, 1914, together with a detailed description of the developments of the field. The following statistics show the production of petroleum in Mexico, by years, since it first came to have industrial importance.

From the best information available the production of petroleum in Mexico from 1907 to 1913 is as follows:

Production of petroleum in Mexico, 1907–1913.

1907	barrels..	1,717,690
1908	do....	3,481,410
1909	do....	2,488,742
1910	do....	3,332,807
1911	do....	14,051,643
1912	do....	16,558,215
1913	do....	25,696,291

The following table shows the quantity of crude petroleum, naphtha, and illuminating oil imported from the United States into Mexico in 1911, 1912, and 1913:

Imports of petroleum and specified products into Mexico from the United States, years ending June 30, 1911, 1912, and 1913.

Kind of oil.	1911		1912		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
Crude	24,398,337	$814,298	22,752,588	$884,320	16,138,930	$590,098
Naphtha	363,101	41,890	314,667	37,373	168,809	27,187
Illuminating	200,252	26,734	165,396	20,607	1,225,289	95,668
Lubricating	1,308,964	253,608	1,060,745	194,270	889,577	211,729
Residuum	1,023,559	27,555	118,758	6,984	15,572	706
Total	27,294,213	1,164,085	24,412,154	1,143,554	18,438,177	925,388

Quantity and value of mineral oils imported into Mexico from the United States, 1904–1913.

Year ending June 30—	Mineral.					
	Crude.		Refined, including residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
1904	10,938,448	$663,575	1,179,894	$222,005	12,118,342	$885,580
1905	14,036,517	786,613	1,216,421	224,061	15,252,938	1,010,674
1906	14,366,495	766,353	3,295,325	616,479	17,661,820	1,382,832
1907	19,992,434	1,037,226	3,906,472	511,990	23,898,906	1,549,216
1908	17,523,440	901,115	1,839,803	320,235	19,363,243	1,221,350
1909	27,554,581	1,184,398	1,979,093	306,579	29,533,674	1,490,977
1910	41,202,786	1,428,632	2,333,558	357,258	43,536,344	1,785,890
1911	24,398,337	814,298	2,895,876	349,787	27,294,213	1,164,085
1912	22,752,588	884,320	1,659,566	259,234	24,412,154	1,143,554
1913	16,138,930	590,098	2,299,247	335,290	18,438,177	925,388

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TRINIDAD.

The production of petroleum in Trinidad has increased in spite of the difficulties in managing drilling operations referred to in the last report of this series. Shipments of crude oil have increased from 183,000 barrels in 1911 to 323,000 barrels in 1913. The production in 1912 amounted to 461,986 barrels; this increased in 1913 to 503,616 barrels. Drilling was active during the year and the total number of wells thus far obtained aggregates 150. In May a gusher of 40,000 barrels capacity was obtained by the American Co., but it soon declined, owing probably to sand heaving.

The official report of Archibald G. Bell, inspector of mines in Trinidad, covering the fiscal year 1912–1913 is quoted as follows:

We are now in the position of knowing that at least three powerful corporations will soon be operating independently in the development of the oil fields of Trinidad, and we shall, therefore, shortly know what position it is going to take in the world.

Taken on the whole, the actual drilling work done by most of the companies can not be said to have been satisfactory. The majority of them seem not to have had sufficient working capital, and, consequently, have not been able to prove properly the oil-bearing prospects of the lands upon which they have been working. Yet, though a great amount of drilling has not been done, several of the wells drilled have proved that the oil sands in certain districts hold large quantities of oil, and that at no great depths. This has been proved at Guapo, and also at the Union Estate, Brighton. Wells were drilled at both places into sands containing large quantities of oil with high gas pressures, and in both cases the production was large and the wells flowed for several weeks. On cessation of gas pressure, the wells continued to give a fair production by pumping and bailing.

Eleven of the companies reported on in my last annual report carried on drilling operations during the year, and four have now closed down. Two new companies started work during the year.

The General Petroleum Properties of Trinidad Limited, did not resume operations at either Aripero or Guayaguayare during the year.

The Trinidad Lake Petroleum Co. (Ltd.) has carried out some very important work in the period under review. It has now practically concentrated work on its Union Estate at Brighton, and has drilled several wells, which have given a very large production. In this field a great amount of additional plant, in the shape of large boiler stations, pumping stations, pipe lines, etc., has been provided to deal with the production and to pump the oil won to the large storage tanks at Brighton. Large earthen storage reservoirs have been dug, large dams built, and additional lengths of asphalt road have been made. Though the company has had a fairly large production, shipments have been comparatively small.

The Trinidad Oilfields (Ltd.), at Point Fortin, has continued to open up the Crown lands held by it under the lease, and it has also continued the drilling operations on its private lands. The chief constructional work, apart from drilling, has been the laying down of large central steam plants, a considerable extension of its light railway, and the laying down of additional pipe lines.

A considerable amount of drilling has been done on its private lands with fair results. On Crown lands, the indications which I mentioned in my last report have been fulfilled, and several successful wells have been drilled. A small experimental refinery was erected during the year, and at the time of writing a larger one has been erected and is working.

The Trinidad Petroleum Options (Ltd.) was in negotiation with the Government during a large part of last year regarding the issue to it of a mining lease, and also the transfer of additional areas under prospecting license. A road was made into its Crown lands, and a bungalow was erected for the accommodation of the staff. A large Galician rig was partially erected, but no drilling was done.

No work has been done by the Trinidad Western Oilfields (Ltd.) during the year, and the prospecting license which it held has now expired.

The Trinidad Cedros Oil Co. (Ltd.) continued boring operations during the first part of the year, and then closed down. Since then no further work has been done.

The Guapo (Trinidad) Oil Co. (Ltd.) during the first half of the year continued its drilling work; since then little has been done with the exception of the extraction of a small quantity of oil.

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During the early part of the year C. C. Stollmeyer continued prospecting work on his Perseverance Estate at Guapo. In June a well was drilled into an exceedingly prolific oil sand. This flowed for nearly two months, and a very large quantity of oil was produced, but, owing to the lack of storage arrangements, a great proportion of this oil flowed down the ravines into the sea and was lost. Since then the work has mainly been in building earthen storage reservoirs and laying pipe lines to convey the oil to the shipping place.

The Trinidad Central Oilfields (Ltd.) has continued the development of the lands held by it under prospecting license at Tabaquite. A number of small wells have been drilled, and in most of them a small production of very high-grade petroleum has been obtained. The refinery was working during the year, and the petrol obtained has been sold locally. The chief work, apart from drilling, has been the erection of further accommodations for the staff, the provision of a multiple pumping station for the wells, stores, and some additional steel storage tanks.

The South Naparima (Trinidad) Oil Co. (Ltd.) closed down work at the end of last financial year. During the latter half of this year, the Venezuelan Oilfield Exploration Co. (Ltd.) took over the wells and part of the properties belonging to it. This company then continued drilling operations during the rest of the year, and has provided steel storage tanks, additional accommodations for the staff, store sheds, etc.

The Tobago Oil Syndicate (Ltd.) continued drilling operations until June, and work was then abandoned.

The Consolidated Oilfields of Trinidad (Ltd.) continued work during the greater part of the year, and then suspended operations. Apart from drilling, little work was done in the field.

During the year Icacos (Trinidad) Development Co. (Ltd.) and the Trinidad Petroleum Developments (Ltd.) started drilling on private lands. Two shallow wells were also drilled with a hand boring machine by a cocoa proprietor at Erin.

Regular inspections of the oil fields have been made during the year, and in most cases the ordinances have been satisfactorily followed. In one case the department took proceedings against an oil-field manager for a breach of the law, and was successful. In addition to the regular inspections in connection with work under leases and licenses, and for the purpose of ascertaining if the ordinances are being followed, numerous special inspections have been made in connection with refineries, dams, roads, etc.

Total number of persons employed in the Trinidad petroleum industry was 801—799 males and 2 females.

GUATEMALA.

Mr. Manuel Lemut, who is engaged in deep drilling for water in Guatemala, reports that up to the close of 1913 no petroleum wells had been obtained, but that surface indications lead to the belief that such deposits may possibly be discovered in the Departments of San Marcos and Huehuetenango, and also in the northern and northeastern parts of the Departments of Quiche, Alta Verapaz, and Izabal. Preparations are being made to explore these deposits.

CENTRAL AMERICA AND THE WEST INDIES.

Interest was shown in the possibility of finding oil in Panama, Costa Rica, Honduras, and Nicaragua, but sufficient time had not elapsed at the end of the year for definitely locating any oil deposits in these countries.

In the islands of the West Indies, prospecting for petroleum was active in Haiti, where a small well was drilled near Azua. In Cuba drilling was resumed near Habana, Cardenas, and Motembo. Explorations for oil were also active in Barbados.

A specimen of manjac obtained from the Bureau of Foreign and Domestic Commerce, Department of Commerce, was examined in the Geological Survey. After finely powdering, five samples of 2 grams each were weighed off and treated with 10 c. c. of the following solvents: Chloroform, carbon bisulphide, carbon tetrachloride, ether, and carefully refined gasoline, boiling between 65° and 95° C., so-called

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normal benzine. After adding the solvent and heating to boiling for a few minutes the samples were allowed to stand for 24 hours. They were then filtered, and each was washed with a small quantity of its solvent. This showed the manjac to be soluble in the various solvents in the following proportions: Chloroform, 90.5 pre cent; carbon bisulphide, 87.1 per cent; carbon tetrachloride, 84.6 per cent; gasoline, 23.15 per cent. In general the solubility of manjac thus resembles gilsonite rather than albertite, grahamite, or elaterite.

A sample of crude petroleum sent by the Consular Service with the sample of manjac showed a gravity of 19.2° Baumé at 60° F., or 0.9383 specific gravity at 15.5° C. The oil was dark brown in color and perfectly sweet in odor, like Pennsylvania petroleum. It contained 11.5 per cent of unsaturated hydrocarbons, which also allies it with the heavier grades of Pennsylvania petroleum such as the natural lubricating oils found at Franklin, Pa. The sample was not large enough for complete examination. The samples are on file in the Bureau of Foreign and Domestic Commerce.

VENEZUELA.

Venezuela is still in the prospecting stage, as described in the report for 1912. After the end of the year 1913 a small yield of oil was obtained near Maracaibo in connection with the asphalt deposits of that region. The well was drilled by the Caribbean Petroleum Co. on the eastern coast of Lake Maracaibo. Oil was struck at a depth of 390 feet and the output was approximately 10 barrels a day. Other wells are being drilled in the neighborhood. The quality of the oil is reported to be of high grade. Two other companies are preparing for development work.

COLOMBIA.

English, American, and Canadian oil interests were concerned in 1913 with concessions for the development of large areas where seepages of oil and asphalt are so significant as to lead to the hope of a large addition to the world's supply of fuel oil. No large wells have yet been developed. The English interests withdrew from Colombia in the latter part of the year. Action of the Colombian legislature developed the policy of disposing of Colombian oil lands by the denouncement method rather than by the concession method.

ECUADOR.

During 1913 negotiations were actively in progress between rival British and American companies with a view to securing a concession from the Government for exploiting both the regions in Ecuador, where the existence of petroleum is probable, as well as the old fields near the coast, which have yielded a small production from time to time. The contract for such concession, which was under consideration between the English company and the Government, and which received the Government's approval, was a very clear proposition, designed to develop the oil resources of Ecuador rapidly.

There is a growing disposition on the part of South American Governments, however, to substitute the method of denouncement by which small tracts of land are outlined by the prospector and are

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turned over to him by the Government in payment for a small sum covering the right to exploit the region outlined for oil. Such a method of disposing of oil lands is practiced in Cuba and, recently, in Panama, Costa Rica, and Colombia.

BOLIVIA.

In addition to the statements concerning the occurrence of petroleum in Bolivia which were given in the report of this series for 1912, a report now in the hands of Director General Barrett, of the Pan American Union, states that the Espejos (mirror) spring, 12 leagues (about 36 miles) from Santa Cruz, in Bolivia, is a fair sample of the character and kind of petroleum surface manifestations found in the region extending from the northern boundary of Argentina to Madre de Dios River. This river is close to the southern boundary of western Brazil, and with the Beni into which it runs, finally joins Mamore River, to form Madeira River. The Espejos spring yields petroleum on its surface, an analysis of which shows a content of 78.2 per cent of kerosene, 17.5 per cent of lubricating oil, and 4.3 per cent of coke. Petroleum in paying quantities will probably be found in other localities as well as in the neighborhood of Santa Cruz.

PERU.

GENERAL CONDITIONS.

The year 1913 was one of the greatest prosperity and the greatest production in the history of the Peruvian fields, owing largely to deeper drilling. The industry is making rapid progress.

In Negritos deep drilling led to developing wells which yielded 300 barrels each a day—some wells more. The limits of one area are fairly well understood; the other area is still undefined but gives promise of good results. As the average total yield per well has in the past not exceeded 20,000 barrels, the great gains within the last few months have caused considerable interest in Peru, and negotiations have begun by English and American companies for the purchase of drilling rights in the fields. Drilling in Negritos is very easy and cheap; even wells 2,500 feet deep require only three months of work.

The Lobitos field is also prosperous, but the ultimate outcome depends upon a program of far more liberal drilling. Wells nearly 3,000 feet deep have given good production, and development is proceeding southward toward the Negritos field, that is, the Parinas Valley north of Talara.

Fair wells have also been developed at Punta Rusten near Cape Blanco. According to A. Beeby Thompson, who has kindly furnished much of the information given herein, there are hundreds of square miles of Tertiary beds in Peru where oil exists in paying quantities. The geology has now been worked out, and it is quite likely that these areas will be developed in the near future. All the fields are cut up by faults along a regular monocline, and there are no anticlines as they are usually interpreted, although, of course, the region of elevation where the oil beds are exposed is a wide fold which might be given this name by a stretch of the term.

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Local use of oil as fuel was stimulated by the introduction of Diesel engines in many localities.

PRODUCTION.

The production of petroleum in Peru in recent years is shown in the following tables:

Production of petroleum in Peru, 1904–1913, in tons and barrels.

Year.	Production.	
	Metric tons.[a]	Barrels.
1904	38,683	290,123
1905	59,720	447,880
1906	71,506	536,294
1907	100,830	756,226
1908	134,824	1,011,180
1909	175,482	1,316,118
1910	177,347	1,330,105
1911	182,436	1,368,274
1912	233,486	1,751,143
1913	247,647	1,857,355

[a] One metric ton=7.5 barrels.

Production of petroleum in Peru, 1905–1913, by districts, in barrels.

Year.	Lobitos.	Negritos.	Zorritos.	Lake Titicaca (Huancane).	Total.
1905	[a] 75,000	335,160	37,720	.....	447,880
1906	162,000	330,510	42,419	1,365	536,294
1907	279,000	396,750	65,476	15,000	756,226
1908	319,898	543,750	71,429	[a] 76,103	1,011,180
1909	429,195	740,070	70,750	[a] 76,103	1,316,118
1910	400,080	773,025	107,000	[a] 50,000	1,330,105
1911	391,290	882,698	64,286	[a] 30,000	1,368,274
1912	587,048	1,071,000	78,095	[a] 15,000	1,751,143
1913	557,355	[a] 1,200,000	[a] 90,000	[a] 10,000	1,857,355

[a] Estimated.

In the following table are given, so far as can now be ascertained, the production, shipments, and stocks of petroleum and the number of producing wells in the Lobitos oil field of Peru in the years 1905 to 1913, inclusive:

Production, shipments, and stocks of petroleum and number of producing wells in Lobitos oil field, 1905–1913.

Year.	Production.		Shipments.	Stock Dec. 31.	Producing wells Jan. 1.
	Metric tons.	*Barrels.*	*Metric tons.*	*Metric tons.*	
1905	[a] 10,000	75,000	.....	.....	.....
1906	[a] 21,600	162,000	17,576	.....	.....
1907	[a] 37,200	279,000	25,821	4,816	.....
1908	42,653	319,898	36,131	8,860	26
1909	57,226	429,195	54,289	11,797	62
1910	53,344	400,080	.....	.....	.....
1911	52,172	391,290	.....	.....	92
1912	78,273	587,048	.....	.....	105
1913[a]	74,314	557,355	.....	.....	110

[a] Estimated.

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The following table gives the production of petroleum in the Negritos oil field of Peru from 1904 to 1913, in tons and barrels:

Production of petroleum in Negritos oil field, Peru, 1904–1913.

Year.	Production.	
	Metric tons.	Barrels.
1904	39,508	296,310
1905	44,688	335,160
1906	44,068	330,510
1907	52,900	396,750
1908	72,500	543,750
1909	98,676	740,070
1910	103,070	773,025
1911	117,693	882,698
1912	142,800	1,071,000
1913[a]	160,000	1,200,000

[a] Estimated.

Production of petroleum in Zorritos oil field of Peru, 1904–1913, in gallons.

Year.	Crude petroleum.	Refined.[a]	Gasoline.	Benzine.
1904	2,080,000	365,000	46,200	
1905	1,584,242	300,000	29,570	
1906	1,781,600	350,000	54,000	10,000
1907	2,750,000	420,000	101,000	20,000
1908	3,000,000	500,000	150,000	30,000
1909	2,971,510	469,610	96,520	.....
1910	4,494,000	.....	.....	.....
1911	[b] 2,700,000	650,000	.....	200,000
1912	3,280,000	476,620	226,440	.....
1913	[c] 3,780,000	.....	.....	.....

[a] Kerosene. [b] 64,286 barrels. [c] Estimated.

ARGENTINA.

The report of this series for 1912 gave a description of the petroleum resources of Argentina, including the deposit at Comodoro Rivadavia, which continues to be the only developed field, with very limited production in comparison with its capacity.

A Government commission is exploiting the reserved producing region, and a careful study is being made of the best methods for securing the greatest benefit to the State from the petroleum resources.

CHILE.

For many years emanations of inflammable gases have been observed in the neighborhood of Punta Arenas and in Tierra del Fuego. These gaseous emanations led to several drilling enterprises in search of petroleum which were without result. In October of 1912 a considerable volume of natural gas was found at the depth of 300 feet, about 1 mile west of Punta Arenas, near Minas River. Films of oil were also noticed on the water brought up by the pumps from this well. On the strength of these discoveries the minister of industry and public works commissioned Prof. E. Miers and Dr. Johannes Felsch, geologist to the minister of industry and public

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works, to make a geologic study of the region. The following is a résumé of the results obtained in this work: Inflammable gases are found in Quemas Malas; on Tres Brazos River, from lower Tertiary clays; on Minas River; near Cape Boqueron in Tres Puentes River; at Pecket Harbor, from sands of the upper Tertiary, and from Otway Gulf. The strata holding the gases are of different ages, but all lie in or below the Tertiary.

In the valleys of Tres Puentes River and of Tres Brazos River and at Cape Boqueron seepages of gas are found in connection with petroliferous rocks, in the immediate vicinity of Tres Brazos River, of Tres Minas, and of Tres Puentes River. In these regions faults have been noted. They probably exist also near Cape Boqueron and Pecket Harbor. Anticlines are found at Quemas Malas and to the north of Cape Yartau in Whiteside Channel. It is also believed that the petroleum will be found in the Cretaceous beds or in still older rocks.

The existence of petroleum has been definitely shown near Punta Arenas and northwest of Tierra del Fuego. The frequency of the emanations of natural gas makes it probable that the petroliferous deposits are large. The geologists have indicated to certain proposed drilling companies the most appropriate places for drilling. The State takes no part in actual drilling, but will continue to further scientific explorations with a view to giving all aid to the search for petroleum.

RUSSIA.

GENERAL CONDITIONS.

The declining condition of the older Russian petroleum localities noted in the previous reports of this series continued in 1913. It was not compensated by increase in the new districts, which include Emba for the first time as a commercial factor. The outlook for the future of Russian production is brightened by the prospecting which has progressed rapidly in the Ural-Caspian region, north of Gurief. The field is reached by steamers to the north shore of the Caspian Sea. About 30 miles from the shore large wells have already been obtained at Dossor, and pipe lines are laid to Gurief, where barges can be loaded and then towed up the Volga without the reloading which is necessary with shipments from Baku. Oil from Baku destined for the Volga River trade arrives at Astrakhan in steamers too deep for the river and is then transferred to barges. Exploration in this Ural-Caspian field has been extended many miles north of the present developments. Prospecting is impracticable in winter, but in summer it can be prosecuted with success in spite of the lack of water, the available supply of which is derived principally from snow scraped up in winter and stored in pits. The inhabitants of the region are nomads living in tents. They are peaceful and disposed to aid exploration.

On June 14, 1913, the first cargo of oil left Dossor for Astrakhan, 130,000 poods on a barge towed by the steamer Carthage. In July Dossor produced 700,000 poods, half from two gushers. Part of it went to Baku and part up the Volga.

Some 500 certificates have been issued for petroleum exploitation in the Kirghiz Steppes in Astrakhan Province. The region is being investigated by Government geologists.

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Uchta.—The Russian Government has carried on systematic investigation of the Uchta region since 1909. The exploration is attended with much difficulty from lack of transportation facilities. Four wells have been drilled, the deepest to 1,050 feet. Two oil sands were found 10 to 35 feet thick. The wells are producing 4 to 6 barrels a day. That from the central part of the anticline is black and heavy—specific gravity 0.920 and smelling of hydrogen sulphide. The oil on the slopes is considerably lighter—0.876 specific gravity and without sulphur; it yields 4 per cent gasoline and 30 per cent kerosene. The region is Paleozoic. The ultimate development waits on better transportation facilities. There is, according to the reports, an outlook for a large number of small wells of very moderate depth, 400 to 600 feet.

PRODUCTION.

The usual tables of production, refining, and shipment follow:

Production of petroleum in Russia, 1904–1913, by fields.

Year.	Baku.		Grosny.		Maikop.	
	Poods.[a]	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.
1904	614,115,445	73,723,290	40,095,331	4,813,365	.....	.....
1905	414,762,000	49,791,356	43,057,052	5,168,914	.....	.....
1906	447,520,000	53,723,389	38,373,003	4,606,075	.....	.....
1907	476,002,000	57,143,097	39,214,012	4,707,037	.....	.....
1908	465,343,000	55,863,504	52,058,895	6,249,567	.....	.....
1909	492,500,000	59,123,050	57,033,015	6,846,700	.....	.....
1910	497,842,212	59,764,971	74,048,358	8,889,359	1,304,800	156,640
1911	434,310,329	52,138,095	75,189,591	9,026,361	7,933,936	952,453
1912	429,300,000	51,536,615	65,400,000	7,851,140	9,200,000	1,104,442
1913	344,538,000	48,563,985	73,659,265	8,842,649	4,802,300	576,507

Year.	Other.		Total.	
	Poods.	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.
1904	.....	.....	654,210,776	78,536,655
1905	.....	.....	457,819,052	54,960,270
1906	[b] 4,721,000	566,747	490,614,003	58,897,311
1907	.....	.....	515,216,012	61,850,734
1908	[c] 611,221	73,376	518,013,116	62,186,447
1909	.....	.....	549,533,015	65,970,350
1910	[d] 12,708,290	1,525,604	585,903,060	70,336,574
1911	[e] 33,876,295	4,066,782	551,310,151	66,183,691
1912	[f] 62,700,000	7,527,011	566,600,000	68,019,208
1913	[g] 24,593,000	2,952,341	447,592,565	60,935,482

[a] 61.05 poods=1 metric ton crude; 8.33 poods crude=1 United States barrel of 42 gallons; 8 poods illuminating oil=1 United States barrel of 42 gallons; 8.18 poods lubricating oil=1 United States barrel of 42 gallons; 9 poods residuum=1 United States barrel of 42 gallons; 7.50 poods naphtha=1 United States barrel of 42 gallons; 8.3775 poods other products=1 United States barrel of 42 gallons, estimated; 1 pood=36.112 pounds; 1 kopeck=0.515 cents.

[b] Produced in Bereki and Tchimion oil fields.

[c] Produced in Surakhany.

[d] Includes 10,613,909 poods produced in Surakhany, 1,392,306 poods produced in Sviatoi, 610,500 poods produced in Ferghana, and 91,575 poods produced in Taman.

[e] Includes 19,896,524 poods produced in Surakhany, 2,515,363 poods produced in Sviatoi, 10,205,740 poods produced in Tcheleken, and 610,500 poods produced in Ferghana.

[f] Includes 43,900,000 poods produced in Surakhany, 3,300,000 poods produced in Sviatoi, 13,300,000 poods produced in Tcheleken, and 2,200,000 poods produced in Ferghana.

[g] Includes 4,733,000 poods produced in Sviatoi, 13,860,000 poods produced in Balakany, and 6,000,000 poods produced along Trans-Caucasian Railway.

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Baku field.—The total production of crude petroleum on the Apsheron Peninsula or Baku field and the shipments of the chief petroleum products from Baku to all points from 1904 to 1913 are shown in the table following:

Total production of crude petroleum on the Apsheron Peninsula and shipments of petroleum products from Baku, 1904–1913, in barrels.

Year.	Production.	Shipments from Baku.					
		Illuminating.	Lubricating.	Other products.	Residuum.	Crude oil.	Total.
1904	73,723,290	19,205,250	1,896,455	159,355	33,622,111	2,249,340	57,132,511
1905	49,791,356	9,209,125	1,303,912	159,045	29,555,777	2,897,359	43,116,218
1906	53,723,889	8,941,125	1,847,799	179,289	22,697,467	4,001,141	37,667,321
1907	57,143,097	11,450,019	1,724,664	565,689	27,833,892	4,290,500	45,864,764
1908	55,863,504	10,682,750	1,754,034	105,163	23,989,778	5,398,200	41,929,925
1909	59,123,650	8,261,368	1,728,833	1,087,115	23,404,954	6,182,973	40,665,243
1910	59,764,971	9,978,406	1,892,046	1,381,921	24,414,210	6,207,278	43,873,861
1911	52,138,095	10,406,454	1,999,503	1,388,776	26,091,096	5,713,538	45,599,367
1912	51,536,615	10,639,886	2,372,605	1,875,209	21,961,469	6,054,524	42,903,693
1913	48,563,985	10,380,813	2,326,931	1,196,169	22,227,408	6,974,106	43,105,427

The division of the production among the districts of the Apsheron Peninsula or Baku field is as follows:

Production of the several districts of the Apsheron Peninsula, 1904–1913, in barrels.

Year.	Balakhani.	Sabunchi.	Romani.	Bibi-Eibat.	Binagadi.	Total.
1904	9,848,380	26,029,292	16,063,505	21,745,618	36,495	73,723,290
1905	6,866,747	16,494,310	11,230,732	15,175,558	24,009	49,791,356
1906	8,142,017	18,739,015	11,489,796	15,317,647	35,414	53,723,889
1907	8,594,118	22,036,734	10,750,901	15,761,344	.....	57,143,097
1908	8,363,960	23,727,367	9,392,357	14,379,720	.....	55,863,504
1909	8,763,505	24,873,950	10,492,198	14,753,901	[a] 240,096	59,123,650
1910	8,228,392	23,379,366	11,532,820	14,265,551	[b] 2,358,842	59,764,971
1911	7,661,934	21,121,650	9,977,837	12,304,431	[c] 1,072,243	52,138,095
1912	7,839,136	20,480,192	9,459,784	12,533,013	1,224,490	51,536,615
1913	7,878,872	19,273,469	8,467,107	11,186,074	1,758,463	48,563,985

[a] Other. [b] Includes 1,286,599 barrels in other districts. [c] 1910.

Production of petroleum from pumping and flowing wells in the Baku field, 1904–1913, by districts, in barrels.

Year.	Balakhani.	Sabunchi.	Romani.	Bibi-Eibat.	Binagadi.	Total.
PUMPING.						
1904	9,848,380	25,384,514	15,043,217	19,061,944	36,495	69,374,550
1905	6,866,747	16,265,306	9,927,971	14,861,945	24,009	47,945,978
1906	8,142,017	18,513,445	10,436,615	15,282,113	35,414	52,409,604
1907	8,594,118	21,676,950	10,353,782	15,137,215	.....	55,762,065
1908	8,363,960	23,585,230	9,250,960	13,529,900	.....	54,729,050
1909	8,763,505	24,849,940	9,843,338	12,953,181	[a] 192,077	56,602,641
1910	8,228,392	23,267,366	10,456,391	13,612,313	[b] 1,323,713	56,888,075
1911	7,661,934	21,086,257	9,774,918	11,306,740	[c] 1,072,243	50,902,092
1912	7,839,136	20,456,182	9,183,674	11,236,494	60,024	48,775,510
1913	7,878,872	19,273,469	8,282,713	10,587,635	1,638,415	47,661,104
FLOWING.						
1904	.....	644,778	1,020,288	2,683,674	.....	4,348,740
1905	.....	229,004	1,302,761	313,613	.....	1,845,378
1906	.....	225,570	1,053,181	35,534	.....	1,314,285
1907	.....	359,784	397,119	624,129	.....	1,381,032
1908	.....	142,137	142,497	849,820	.....	1,134,454
1909	.....	24,010	648,860	1,800,720	[a] 48,019	2,521,609
1910	.....	112,100	1,076,429	653,238	[a] 1,035,129	2,876,896
1911	.....	35,393	202,919	997,691	.....	1,236,003
1912	.....	24,010	276,110	1,296,519	1,164,466	2,761,105
1913	.....	.....	184,394	598,439	120,048	902,881

[a] Other. [b] Includes 251,470 barrels in other districts. [c] 1910.

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Number and condition of wells in the Baku fields in years ending Dec. 31, 1912 and 1913.

Condition of wells.	Balakhani.		Sabunchi.		Romani.		Bibi-Eibat.		Total.	
	1912	1913	1912	1913	1912	1913	1912	1913	1912	1913
Completed	60	68	111	112	39	23	17	22	227	225
Producing, Dec. 31	888	934	1,118	1,288	282	290	300	331	2,588	2,843
Trial pumping, Dec. 31	9	12	29	25	1	3	13	1	52	41
Drilling, Dec. 31	41	73	72	107	33	40	37	66	183	286
Drilling deeper, Dec. 31	16	20	25	22	12	13	19	17	72	72
Cleaning out and repairing	6	32	26	107	15	61	11	57	58	257
Standing idle	335	394	608	616	220	231	158	157	1,321	1,398
Rigs up, ready for drilling	24	45	60	75	6	8	20	12	52	140
New wells sunk	79	100	119	143	33	30	21	46	110	319
Length of wells drilled, in feet	92,743	115,269	172,739	198,184	64,134	56,595	45,255	83,902	374,871	453,950

The stocks of petroleum and petroleum products in the Baku field at the close of the year from 1909 to 1913 were as follows:

Stocks of petroleum in Baku, Dec. 31, 1909–1913, in barrels.

	1909	1910	1911	1912	1913
At oil wells: Crude	1,080,432	938,391	906,625	952,676	1,068,427
At refineries:					
Crude	2,495,087	3,073,853	1,887,270	2,551,577	2,081,428
Illuminating	938,971	947,024	1,028,885	1,268,626	1,144,663
Lubricating	247,358	272,017	272,170	260,397	260,599
Residuals	4,703,372	5,647,526	3,195,771	3,396,775	2,817,656
Other products	234,048	224,240	306,825	443,643	374,909
Total	9,699,268	11,103,051	7,597,546	8,873,694	7,747,682

Grosny field.—The following tables show the production in the Grosny field from 1909 to 1913:

Production of petroleum in the Grosny oil field, 1909–1913, in poods and barrels.

Year.	Pumping.		Flowing.		Total.	
	Poods.	*Barrels.*	*Poods.*	*Barrels.*	*Poods.*	*Barrels.*
1909	50,997,451	6,122,143	6,035,564	724,557	57,033,015	6,846,700
1910	58,097,733	6,974,518	15,950,625	1,914,841	74,048,358	8,889,359
1911	71,481,505	8,581,213	3,708,086	445,148	75,189,591	9,026,361
1912	65,319,687	7,841,499	109,920	13,196	65,429,607	7,854,695
1913	68,643,505	8,240,517	5,015,760	602,132	73,659,265	8,842,649

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Well record in the Grosny field in 1909–1913.

Year.	Number of plots.		Total wells.	Producing, Dec. 31.	Boring and deepening, Dec. 31.	Average depth of wells.	Total sum of depth of producing wells.	Total length of wells drilled in the year.
	Producing.	Being exploited.						
						Feet.	*Feet*	*Feet.*
1909	.....	.....	320	182	58	1,458.1	250,831	82,537
1910	44	71	343	234	67	1,557	.....	87,836
1911	80	195	358	195	61	1,670	.....	72,933
1912	.....	223	402	264	71	1,752	.....	119,165
1913	83	280	554	352	116	1,798	.....	201,867

Crude petroleum on hand in Grosny field Jan. 1, 1910, 285,829 barrels; Dec. 31, 1910, 787,949 barrels; Dec. 31, 1911, 141,649 barrels; Dec. 31, 1912, 245,583 barrels.

Novorossisk.—The following tables show the shipments of petroleum and its products from Novorossisk from 1907 to 1912, and stocks on December 31, 1912 and 1913:

Shipments of petroleum from Novorossisk, 1907–1913, in metric tons.

Year.	Crude oil.	Illuminating.a	Benzine.	Residuals.	Total.
1907	.....	34,414	31,543	24,922	90,879
1908	.....	15,824	38,690	18,112	72,626
1909	.....	23,248	54,800	49,920	127,968
1910	6,025	32,187	63,232	67,973	169,417
1911	15,690	62,044	65,520	76,092	222,346
1912	.....	90,444	123,098	24,817	238,359
1913	.....	69,216	120,000	20,973	210,189

a Refined.

Stocks of petroleum at Novorossisk, Dec. 31, 1911, 1912, and 1913.

	1911		1912		1913	
	Poods.	Barrels.	Poods.	Barrels.	Poods.	Barrels.
Crude	179,800	21,585	72,000	8,643	100,600	12,077
Illuminating oils	317,600	39,700	443,400	55,455	738,100	92,263
Astatki	282,000	31,333	230,000	25,555	839,000	93,222
Other products	1,361,000	162,459	1,073,900	127,845	1,736,500	207,281
Total	2,140,400	255,077	1,819,300	217,468	3,414,200	404,843

Batum.—The following table shows the shipments of petroleum products from Batum from 1909 to 1913:

Shipments of petroleum from Batum, 1909–1913.

Year.	Refined petroleum.	Lubricating.	Residuals.	Total.
	Metric tons.	*Metric tons.*	*Metric tons.*	*Metric tons.*
1909	405,857	164,840	78,839	649,536
1910	423,993	157,608	45,811	627,412
1911	353,518	171,725	57,282	582,525
1912	327,338	188,894	53,300	569,532
1913	454,165	183,180	62,594	699,939

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The following were the stocks of petroleum products held at Batum at the close of the year from 1909 to 1913, in poods and barrels:

Stocks of petroleum at Batum, Dec. 31, 1909–1913.

	1909		1910		1911		1912		1913	
	Poods.	*Barrels.*	*Poods.*	*Barrels.*	*Poods.*	*Barrels.*	*Poods.*	*Barrels.*	*Poods.*	*Barrels.*
Illuminating	2,700,000	350,000	2,590,778	323,847	2,216,007	278,251	3,384,654	423,082	1,777,723	222,215
Lubricating	972,000	118,826	1,092,431	133,670	888,605	108,631	2,009,475	245,657	1,458,001	178,240
Solar oil	24,000	3,000	522,032	60,000	300,585	35,880	963,794	107,088	1,063,459	118,162
Vaseline	158,000	18,860								
Residuals	577,000	64,111								
Total	4,431,000	554,797	4,205,241	517,517	3,405,197	422,762	6,357,923	775,827	4,299,183	518,617

AUSTRIA-HUNGARY.

GALICIA.

Production.—Production in Galicia has been declining continuously since 1909 at the rate of about 2,000,000 barrels a year. In 1913, however, the decline was less than 1,000,000 barrels or from 8,535,174 barrels of 42 gallons each in 1912 to 7,818,130 barrels in 1913. The decline came altogether from Tustanowice, the dominating field of Galicia. In the other districts, Boryslaw and West Galicia, an increase was shown. There was a considerable decline in the amount of oil exported from Austria-Hungary and a large increase in the imports.

The Austrian railways have partly abandoned the use of oil on their northwestern lines and have reintroduced coal as fuel

Oil production from hand-dug wells has entirely ceased in Galicia, the number of such hand-dug wells having been reduced to 15, and on these no work was done during the year. Forty-three producing wells were worked by hand pumps, 914 by steam, 620 by gas motors, and 18 were flowing wells. There are also 861 wells which were not productive. Of the wells in the Boryslaw-Tustanowice area 252 exceeded 4,000 feet, the deepest having reached 5,400 feet, or over one mile.

The Canadian pole system of drilling is used almost entirely, the hydraulic system being forbidden by the authorities who have the questionable belief that this method is apt to drown out the oil strata.

A union formed among the producers in Galicia is devoting every possible effort to the discovery of new oil territory with good prospects of success.

Production of petroleum in Galicia, 1904–1913.

Year.	Metric centners.[a]	Barrels of 42 gallons.	Year.	Metric centners.[a]	Barrels of 42 gallons.
1904	8,271,167	5,947,383	1909	20,767,400	14,932,799
1905	8,017,964	5,765,317	1910	17,625,600	12,673,688
1906	7,604,432	5,467,967	1911	14,629,400	10,519,270
1907	11,759,740	8,455,841	1912	11,870,070	8,535,174
1908	17,640,220	12,612,295	1913	110,872,860	7,818,130

[a] 1 metric centner or quintal=100 kilograms (220.462 pounds); 1 metric centner or quintal of crude petroleum=0.71905 barrel of 42 gallons.

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In the following table is given the production of petroleum in Galicia in 1909 to 1913, inclusive, by fields, in tons:

Production of petroleum in Galicia, 1909–1913, by fields, in metric tons. [a]

Field.	1909	1910	1911	1912	1913
East Galicia:					
Tustanowice	1,706,435	1,404,320	1,105,420	856,440	691,382
Boryslaw	231,195	209,300	197,320	170,500	205,904
Schodnica	34,860	32,860			
Urycz					
Mraznica	28,110	38,170			
Other fields					
West Galicia:					
Potok	11,370	13,010	160,200	160,067	190,000
Rogi	9,540	8,200			
Rowne					
Krosno	20,690	25,200			
Tarnawa-Wielopole-Zagorz	6,770	2,700			
Kobylanka, Kryg, Zalawie, Lipinki, Libussa, etc	27,770	28,300			
Total	2,076,740	1,762,560	1,462,940	1,187,007	1,087,286

[a] 1 metric ton=7.1905 barrels of crude petroleum of 42 gallons=2,204.62 pounds.

Deliveries of Galician petroleum to refineries, 1908–1912, in metric tons.

	1908	1909	1910	1911	1912
Deliveries to refineries:					
In Galicia and Bucovina	457,020	451,290	362,160	392,020	533,500
In the rest of Austria	540,820	672,970	547,920	488,770	535,160
In Hungary	338,720	384,090	319,380	347,550	313,930
To the State refinery in Drohobycz			208,760	337,340	372,270
Total	1,336,560	1,508,350	1,438,250	1,565,680	1,754,860
Exported		41,920	3,280	840	1,010
Used as fuel		120,000	97,430	90,120	33,910
Stocks in Government reservoirs		406,470	819,700	[a] 871,330	[b] 512,540
Total		2,076,740	2,358,660	2,527,970	2,302,320

[a] Does not include producers' storage, which decreased from 858,490 tons to 605,280 tons.
[b] Does not include producers' storage, which decreased to 280,510 tons.

Imports and exports.—In the following table are given the imports and exports of petroleum products into and from Austria-Hungary in 1910–1913:

Imports and exports of petroleum into and from Austria-Hungary in 1910–1913, in metric tons.

Kind.	1910		1911		1912		1913	
	Imports.	Exports.	Imports.	Exports.	Imports.	Exports.	Imports.	Exports.
Illuminating oils	1,460	266,739	1,517	265,378	1,377	383,183	1,868	285,445
Lubricating and other oils	15,358	139,071	18,213	91,065	19,687	155,583	27,087	155,907
Benzine	40	39,320	10	41,904	89	68,698	2,683	49,773
Paraffin	455	44,432	631	37,940	546	51,594	300	43,101
Crude petroleum	18,967	5,472	19,020	610	17,873	1,660	19,134	1,112
Ozokerite					150	2,525	146	2,275
Ceresin					39	1,712	16	1,550
Total	36,280	495,034	39,391	436,467	39,761	664,955	51,184	539,163

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The conditions of oil refining in Galicia are well described by Dr. A. Guiselin, secretary of the International Petroleum Commission.[1]

ROUMANIA.

GENERAL CONDITIONS.

In spite of the Balkan war, with its depressing effects upon all industries, and of two unusually disastrous fires in the oil fields, the Roumanian producers succeeded in increasing, though very slightly, the total production of crude petroleum as is shown in the following tables, which give also valuable data as to the total yield of the chief products of the refineries.

In spite of the mobilization of the Roumanian Army in June and the consequent loss of workmen and drillers, exploitation increased as to both drilled and hand-dug wells. A gusher drilled in January, known as well No. 79 of the Columbia Co., at Gropi, opened new territory connected with Chiciura. In February the Astra-Romana Co. struck a gusher at Staropoleos-Moreni which added new territory west of previous developments in the Moreni field. In March the Romana-Americana Co.'s well No. 2 Fierbatori (Baicoi) proved a violent gusher and also opened new territory. In March also came a great fire at Moreni-Bana, caused by an oil well explosion, of which Harold Masterson, engineer of the Roumanian Consolidated Oil Fields, was a victim. The Steaua Romana obtained in this month its first well at Runcu, opening territory between the Bordeni and the Chiciura pools. In July the conclusion of peace in the Balkan States and the demobilization of the army in August caused considerable increase in oil operations. Several wells were drilled to the north of Mislishoara, adding new territory to that important region. But the industry received a serious setback in October by a well explosion and fire lasting 14 days, in which 17 wells were destroyed, among them the great gusher Columbia No. 1, which had yielded in all about 2,600,000 barrels of oil. Important progress was made in the construction of the pipe line from the oil fields to Constantza, on the Black Sea.

An invitation was extended early in the year for a general session at Bucharest of the International Petroleum Commission, but this was withdrawn in August. Meantime the minister of industries decided to found an International Petroleum Institute with headquarters in Bucharest. The organization of this institute was completed in December, and all nations were invited to join in it. Meanwhile the International Petroleum Commission also took into consideration the transformation of the commission into an international institute, and correspondence was active with a view to harmonizing the two propositions.

About 12,000 persons are employed in the oil-producing industry, 94 per cent of them Roumanians. Over 4,000 tank cars were in service in Roumania in 1913, consuming 1,500,000 barrels of oil. This was 64 per cent of the total fuel burned in the 780 locomotives. The remaining fuel was chiefly Roumanian coal; 8 per cent was wood.

[1] Bulletin mensuel de l'Association amicale: L'Ecole de physique et de chimie industrielles, Paris, May, 1912.

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The crude oil, residues, etc., transported amounted to 675,615 metric tons; refined products aggregated 523,809 tons. The average revenue per ton of oil transported was $1.

Production of petroleum in Roumania in 1912 and 1913, by districts and months, in metric tons. [a]

1912.

Month.	District Prahova.					Dambovitza.	Buzeu.	Bacau.	Total.
	Bustenari-Calinet-Bordeni.	Campina Poiana.	Moreni.	Other.	Total.				
January	22,380	28,563	50,444	10,564	111,951	9,105	4,260	2,332	127,648
February	21,702	33,582	60,010	9,816	125,110	11,965	5,616	2,950	145,641
March	23,935	27,984	60,286	10,091	122,296	10,385	5,537	1,394	139,612
April	26,959	24,254	66,749	9,680	127,642	6,677	6,693	2,261	143,273
May	28,784	24,089	63,371	11,402	127,646	5,523	8,124	3,408	144,701
June	27,815	22,978	81,357	12,136	144,286	5,232	8,807	3,305	161,630
July	25,535	23,242	93,566	11,900	154,243	5,175	7,014	2,959	169,391
August	26,476	22,599	75,167	10,624	134,866	4,914	6,450	2,399	148,629
September	24,767	20,880	90,471	15,182	151,300	3,726	7,614	1,699	161,339
October	24,854	21,415	87,375	13,208	146,852	4,124	8,999	1,971	161,946
November	22,769	21,507	71,798	12,563	128,637	3,806	7,954	1,901	142,298
December	25,655	24,312	77,507	12,398	139,872	3,684	10,203	1,894	155,653
Total	301,631	295,405	878,101	139,564	1,614,701	74,316	87,271	28,473	1,804,761

1913.

January	30,869	22,285	85,485	12,465	151,104	3,356	9,602	2,103	166,165
February	25,265	21,595	76,685	10,396	133,941	2,838	8,512	2,462	147,753
March	25,149	23,151	78,637	15,991	142,828	2,710	10,217	2,767	158,522
April	23,988	21,298	88,087	12,952	146,325	2,734	10,107	4,517	163,683
May	24,786	22,160	84,617	12,178	143,741	3,499	10,162	4,014	161,416
June	26,115	21,327	88,862	10,996	147,300	3,874	10,075	3,798	165,047
July	25,094	20,881	84,481	10,786	141,242	3,739	8,880	2,365	156,226
August	21,333	19,219	88,167	9,506	138,225	3,540	9,167	2,733	153,665
September	20,809	17,536	82,979	13,575	134,909	3,455	11,306	3,637	153,397
October	28,946	18,948	86,717	14,287	148,898	3,532	12,054	3,776	168,260
November	26,904	17,962	61,766	12,617	119,249	3,782	12,002	4,021	139,054
December	24,356	17,353	75,470	12,728	129,907	4,524	13,638	3,968	152,037
Total	303,614	243,715	981,953	148,477	1,677,759	41,583	125,722	40,161	1,885,225

[a] 1 metric ton=7.19 barrels of 42 gallons.

The following table gives the statistics of the production of petroleum in Roumania in 1909–1913:

Roumanian petroleum industry, 1909–1913, in metric tons.

	1909	1910	1911	1912	1913
Crude-oil production	1,297,257	1,352,407	1,544,847	1,804,761	1,885,225
Crude oil treated at refineries	1,107,825	1,215,299	1,404,403	1,668,389	1,787,245
Output of refineries:					
Benzine	201,253	230,703	260,653	352,492	422,019
Illuminating oil	263,998	272,222	312,711	345,802	380,074
Lubricating oil	43,446	25,064	24,703	43,438	48,416
Residuals	576,600	667,260	783,136	898,011	906,735
Home consumption:					
Benzine	14,041	20,314	24,450	30,656	30,131
Illuminating oil	39,451	41,849	43,941	49,941	51,396
Lubricating oil	15,698	17,544	22,401	28,997	33,725
Residuals	366,703	360,551	434,094	540,383	560,492
Fuel at the refineries	109,077	108,314	123,029	140,590	135,728
Exports:					
Benzine	108,218	125,751	124,384	173,817	237,168
Illuminating oil and distillate	261,637	339,282	318,441	353,563	418,622
Crude, residuals, etc.	49,715	116,223	233,895	318,443	390,077
Paraffin	545	285	476	600	579
Stocks on Dec. 31:					
Benzine	40,071	29,006	51,862	60,647	66,746
Illuminating oil	79,613	56,557	73,908	126,009	145,486
Lubricating oil and residuals	157,204	270,493	248,375	227,140	79,766

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The percentage of the total production furnished by each of the departments of Roumania is given in the following table:

Percentage of production of petroleum in Roumania, 1909–1913, by departments.

Department.	1909	1910	1911	1912	1913
Prahova	94.23	92.10	89.67	89.51	89.00
Dambovitza	2.33	3.20	4.47	4.11	2.21
Buzeu	1.96	2.94	4.08	4.83	6.66
Bacau	1.48	1.76	1.78	1.55	2.13
Total	100.00	100.00	100.00	100.00	100.00

Percentage of refined products from Roumanian crude petroleum, 1909–1913.

Product.	1909	1910	1911	1912	1913
Crude benzine	18.1	19.0	18.6	21.2	23.6
Illuminating oil	23.8	22.4	22.3	20.7	21.3
Lubricating oil	3.9	2.0	1.8	2.6	2.7
Residue	52.0	54.9	55.8	53.8	50.7
Loss	2.2	1.7	1.5	1.7	1.7

The production of petroleum in Roumania in the last 10 years has been as follows:

Production of petroleum in Roumania, 1904–1913, in barrels.

Year.	Quantity.	Year.	Quantity.
1904	3,599,026	1909	9,327,278
1905	4,420,987	1910	9,723,806
1906	6,378,184	1911	11,107,450
1907	8,118,207	1912	12,976,232
1908	8,252,157	1913	13,554,768

WELL RECORD.

The well record in Roumania in 1913 is shown in the following table:

Well record in Roumania in 1913, by districts.

District.	Jan. 1, 1913.						Dec. 31, 1913.					
	Bore holes.			Hand wells.			Bore holes.			Hand wells.		
	Producing.	Drilling.	Abandoned.	Producing.	Drilling.	Abandoned.	Producing.	Drilling.	Abandoned.	Producing.	Drilling.	Abandoned.
Prahova	740	259	460	104	92	299	761	359	495	99	86	271
Dambovitza	18	21	19	61	11	138	24	8	23	58	7	148
Buzeu	48	43	23	44	2	59	72	33	27	52	2	50
Bacau	55	17	40	283	86	435	87	11	15	328	22	462
Putna	.....	1	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
Total	861	341	542	492	191	931	944	411	561	537	117	931

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EXPORTS.

In the following table are given the exports of petroleum products from Roumania in the years 1909–1913, in tons:

Exports of petroleum products from Roumania in 1909–1913, in metric tons.

Kind.	1909	1910	1911	1912	1913
Crude oil, gas oil, lubricating oil, and residuals	49,715	116,223	124,384	173,817	237,168
Illuminating oil	261,637	339,282	318,441	353,563	418,622
Benzine	108,218	125,751	233,895	318,443	380,077
Paraffin scale	545	285	476	600	579
Total	420,115	581,541	677,196	846,423	1,036,446

GERMANY.

In the following table are shown the quantity and value of petroleum produced in the German Empire, by States, from 1904 to 1913, inclusive:

Production of petroleum in the German Empire, 1904–1913, by States.

Year.	Alsace-Lorraine.	Prussia and Bavaria.	Total.		Total value.	
	Quantity.	Quantity.	Quantity.			
	Metric tons.	*Metric tons.*	*Metric tons.*	*Barrels (42 gallons).*	*Marks.*	*Dollars.*
1904	22,016	67,604	89,620	637,431	5,805,000	1,381,590
1905	21,128	57,741	78,869	560,963	5,207,000	1,239,266
1906	[a] 22,154	59,196	81,350	578,610	5,036,000	1,198,568
1907	[a] 26,124	80,255	106,379	756,631	7,056,000	1,679,328
1908	[a] 28,898	113,002	141,900	1,009,278	9,942,000	2,366,196
1909	[a] 29,726	113,518	143,244	1,018,837	10,118,000	2,408,084
1910	.....	.....	145,168	1,032,522	10,146,000	2,414,748
1911	.....	.....	142,992	1,017,045	10,045,000	2,390,710
1912	.....	.....	144,961	1,031,050	10,190,000	2,425,220
1913	.....	.....	[b] 140,000	995,764	9,790,285	2,330,068

[a] Includes Bavaria. [b] Estimated.

1 metric ton, crude=7.1126 barrels.

GREAT BRITAIN.

Oil shale.—In the following table is shown the production of oil shale in Great Britain in 1904 to 1913, taken from the Mineral Statistics of the United Kingdom:

Quantity and value of oil shale produced in Great Britain, 1904–1913, in long tons.

Year.	England.		Scotland.		Wales.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1904	.....	.....	2,331,885	$2,695,578	1,177	$2,146	2,333,062	$2,697,725
1905	2,000	$2,920	2,493,081	2,881,343	1,704	2,890	2,496,785	2,887,153
1906	.....	.....	2,545,724	3,200,449	798	1,358	2,546,522	3,201,807
1907	.....	.....	2,690,028	3,923,971	.....	.....	2,690,028	3,923,971
1908	.....	.....	2,892,039	3,870,118	.....	.....	2,892,039	3,870,118
1909	40	34	2,967,017	3,970,723	.....	.....	2,967,057	3,970,757
1910	.....	.....	3,130,280	4,189,114	.....	.....	3,130,280	4,189,114
1911	.....	.....	3,116,803	4,171,174	.....	.....	3,116,803	4,171,174
1912	.....	.....	3,184,826	3,726,425	.....	.....	3,184,826	3,726,425
1913 [a]	.....	.....	3,000,000	3,700,000	.....	.....	3,000,000	3,700,000

[a] Estimated.

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NEW SOUTH WALES.

Quantity and value of oil shale produced in New South Wales, 1902–1913, in long tons.

Year.	Quantity.	Value.
1902	62,880	$290,613
1903	34,776	139,265
1904	37,871	130,276
1905	38,226	103,399
1906	32,446	138,549
1907	47,331	154,996
1908	46,303	126,855
1909	48,718	114,932
1910	68,293	164,955
1911	75,104	179,965
1912	[a] 75,000	180,000
1913	[a] 75,000	180,000

[a] Estimated.

ITALY.

In the following table will be found the production of petroleum in Italy from 1904 to 1913. This table is taken from the volumes of the Rivista del Servizio Minerario:

Production of petroleum in Italy, 1904–1913.

Year.	Number of wells in operation.	Quantity.		Value.	
		Metric tons.	United States barrels.	Lire.[a]	Dollars.
1904	10	3,543	25,476	1,053,294	203,286
1905	9	6,123	44,027	1,826,802	352,573
1906	12	7,451	53,577	2,226,559	429,726
1907	13	8,327	59,875	1,663,300	321,017
1908	14	7,088	50,966	1,415,640	273,219
1909	12	5,895	42,388	1,178,060	227,481
1910	9	7,069	50,830	1,413,800	272,863
1911	9	10,390	74,709	1,454,600	280,737
1912	9	7,479	53,778	1,196,640	230,952
1913 [b]	9	7,000	50,334	1,000,000	193,000

[a] Lira=$0.193. 1 metric ton, crude=7.1905 barrels. [b] Estimated.

BRITISH INDIA.

The following table gives the production of petroleum in India from 1904 to 1913 in imperial gallons reduced to barrels of 42 gallons and in rupees reduced to dollars:

Production and value of petroleum in India, 1904–1913.

Year.	Quantity.		Value.	
	Imperial gallons.	Barrels (42 United States gallons).	Rupees.[a]	Dollars.
1904	118,491,382	3,385,468	7,109,566	2,303,499
1905	144,798,444	4,137,098	9,063,051	2,936,429
1906	140,553,122	4,015,803	8,613,576	2,790,799
1907	152,045,677	4,344,162	9,150,225	2,968,637
1908	176,646,320	5,047,038	10,530,135	3,416,327
1909	233,678,087	6,676,517	13,652,580	4,429,352
1910	214,829,647	6,137,990	12,538,905	4,068,039
1911	225,792,094	6,451,203	13,265,970	4,303,923
1912	249,083,518	7,116,672	14,629,170	4,746,190
1913	277,555,225	7,930,149	15,518,790	5,035,803

[a] The value of the rupee is taken as 32.44½ cents; 15 rupees=£1.

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Production of petroleum in India, 1908–1913, by Provinces, in imperial gallons.

Province.	1908	1909	1910	1911	1912	1913
Burma	173,402,790	230,396,617	211,507,903	222,225,531	245,335,209	272,865,307
Eastern Bengal and Assam	3,243,110	3,280,750	3,320,680	3,565,163	3,747,359	4,688,628
Punjab	420	720	1,064	1,400	950	1,200
Total	176,646,320	233,678,087	214,829,647	225,792,094	249,083,518	277,555,225

DUTCH EAST INDIES.

In the following table is given the production of petroleum in the Dutch East Indies during the years 1904 to 1913, inclusive:

Production of petroleum in Dutch East Indies, 1904–1913.

Year.	Borneo.		Java.		Sumatra.		Total.		
	Metric tons.	Liters.	Metric tons.	Liters.	Metric tons.	Liters.	Metric tons.	Liters.	Barrels.
1904	215,109	238,327,180	110,053	127,692,388	542,936	668,731,900	868,098	1,034,751,468	6,508,485
1905	439,487	486,924,000	110,711	128,456,000	513,630	632,635,700	1,063,828	1,248,015,700	7,849,896
1906	387,455	429,275,398	111,378	129,229,083	602,501	742,097,300	1,101,334	1,300,601,781	8,180,657
1907	489,151	541,948,068	142,983	165,900,000	713,841	879,235,063	1,345,975	1,587,083,131	9,982,597
1908	511,049	566,209,890	137,013	158,974,000	738,588	909,715,827	1,386,650	1,634,899,717	10,283,357
1909	411,506	455,922,397	140,351	162,846,428	922,894	1,136,720,015	1,474,751	1,755,488,840	11,041,852
1910	633,472	701,853,114	142,503	165,344,877	719,740	886,505,130	1,495,715	1,753,703,121	11,030,620
1911	814,707	902,654,621	172,438	190,766,435	683,523	841,895,279	1,670,668	1,935,316,335	12,172,949
1912	671,662	744,167,950	184,989	214,641,699	621,481	765,481,929	1,478,132	1,724,291,578	10,845,624
1913	797,059	883,061,666	207,135	366,608,237	529,947	652,735,720	[a]1,534,223	1,902,550,755	11,966,857

[a] Includes 82 metric tons produced in Ceram.

1 gallon Borneo crude=7.5322 pounds.
1 gallon Java crude=7.1924 pounds.
1 gallon Sumatra crude=6.7754 pounds.
1 United States barrel=158.985 liters; 1 liter=1.0567 quarts.

TIMOR.

Consul General George E. Anderson, of Hongkong, gives the following information concerning the occurrence of oil on the island of Timor.[1]

Timor is an island about 263 miles long and 60 miles wide at its greatest breadth, 2,100 miles from Hongkong and 436 miles from Port Darwin, the nearest important port. The eastern half, where the oil fields are being developed, belongs to Portugal, and the western part to the Netherlands. The climate is considered good.

There are 4 principal oil concerns—1 of Hongkong, 1 of England, and 2 of Sydney, Australia. The fields of the Hongkong company are near the seacoast at an elevation of 200 to 300 feet above the sea, which permits the transportation of oil by pipe line and gravity. Operations here are conducted with American machinery and along the lines followed in California and similar fields. The English company must transport its supplies and machinery over a mountain range and for a considerable distance in the undeveloped interior. The work of this company so far has, therefore, consisted largely in road building and other preliminary arrangements, but the concern is now ready for boring. Both the Australian companies are using more or less American machinery.

Experts report prospects of a considerable supply of oil from Timor in the near future, a strong flow being expected at a depth of 1,200 to 1,500 feet. The oil yields a high-grade kerosene. Tested by the Hongkong Government, oil obtained on the property of the Hongkong company showed a flashing point (Abel close test) of 112°

[1] Daily Cons. Repts., Jan. 9, 1914.

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F. and had a specific gravity of 0.8403. British tests of oil from other concessions have shown 64.6 per cent of kerosene and about 30 per cent of intermediate lubricating oils. Pools of black viscid oil found on the surface of the island have given oil suitable for fuel, and on much of the island limestone coated with bitumen and ozokerite is found on the surface which yields 24 per cent, by weight, of crude, heavy oil.

Work has been greatly interfered with by a recent rebellion of natives, which has now been subdued. Ordinarily labor is abundant and cheap, 10 cents gold per day for unskilled labor being the customary wage. The natives are more Papuan than Malay, and are fair workmen; but they are divided into numberless small tribes, which are constantly at war with one another.

Concessions from the Portuguese Government are usually in lots of 1,250 acres. The laws are fairly liberal, customs duties and moderate license fees being the chief charges. Development is retarded chiefly by expensive transportation and the necessity of importing from Hongkong or Australia nearly all supplies needed for Europeans.

CHINA.

Petroleum is produced in China in the Province of Szechwan, in the neighborhood of the village of Lou Tcheou, where the industry is of great antiquity. The production in this Province amounts at present to about 30,000 barrels a year. Oil is also produced in the neighborhood of Yenan Fu, in the Province of Shensi. There are indications of oil in many other localities in Kansu and Chili.

About the end of the year 1913 the Standard Oil Co., of New York, it is reported, entered into an agreement with the Chinese Government by which the exclusive privilege is given to that company of studying the oil indications of China with a view to selecting oil fields in such Provinces as prove attractive; this study is to be carried out at the joint expense of the Standard Oil Co., of New York, and the Chinese Government. If the results are favorable a Sino-American company will be formed to exploit the fields.

JAPAN.

During 1913 about 50 rotary drilling rigs were introduced into Japan and have been sufficiently successful to result in an increase in the total production. Production increased in Formosa also.

The rotary system is to be credited with drilling in the first Japanese gusher, on May 22, 1914, near Akita. It gave several thousand barrels a day from a sand 54 feet thick found at a depth of about 1,400 feet and well covered by shales. No water was found with the oil.

According to Consul General George H. Scidmore, of Yokohama, the Nippon and the Hoden oil companies have contracted to supply the Japanese Navy with 10,500 tons of petroleum for one year. He states also that the press of Japan has been publishing glowing reports of sudden alleged enormous output of petroleum in Akita Ken. A clipping from the Japan Mail gives particulars in this connection:

> As a result of the extraordinary gush of oil in Akita prefecture Japanese shipping circles will derive beneficial effects after the Panama Canal is opened. The authorities are under this belief and state that Japan imported oil in 1913 to the value of $6,000,000 gold. If the well in the prefecture yields oil at its present rate its value will be $600,000 in one month. If the oil company will equip suitable receptacles it will not only stop further import of oil but will amply supply it to foreign markets. In consequence, a majority of oil-burning vessels coming to the Pacific through the canal will stop in Japan to take liquid fuel. The number of foreign ships coming to Japan in this way will greatly increase, which will directly or indirectly benefit this country.

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Mr. K. Ito, superintendent of the investigation department of the Nippon Oil Co., states: "Work begun on the new well in April. On May 25 the rotary drill at 1,368 feet struck an extraordinary deposit. It is also extraordinary that the company's other five wells in the district, which had required suction pumps, have also begun flowing of their own accord. Many reservoirs have been constructed, into which the flow was directed. The new well was sunk with an 8-inch casing, which has been capped with a 4-way head, thereby controlling the flow. The output has thus been reduced from 480,000 gallons to 120,000 gallons per 24 hours, and when the additional reservoir is filled will again be reduced. In the meantime the other five wells have been checked entirely.

The Japan Gazette, however, expresses some doubt as to the exact truth of these reports and counsels caution in receiving them, pending official and expert confirmation.

In the following table is given the production of petroleum in Japan from 1904 to 1913, inclusive:

Production of petroleum in Japan, 1904–1913.[a]

[Barrels of 42 gallons.]

Year.	Crude.	
	Koku.	*Barrels.*
1904	1,249,536	1,419,473
1905	1,296,482	1,472,804
1906	1,501,563	1,705,776
1907	1,755,464	1,994,207
1908	1,815,001	2,061,841
1909	1,657,036	1,882,398
1910	1,520,453	1,727,240
1911	1,529,593	1,737,618
1912	1,458,290	1,656,617
1913	1,603,582	1,923,909

[a] Exclusive of the island of Formosa.

1 koku=39.7 English gallons=47.46 United States gallons=1.136 United States barrels.

In the following table is given a statement of the production of petroleum in Japan, 1905–1913, by fields, as reported by the mining bureau of the department of agriculture and commerce, Tokyo:

Production of petroleum in Japan, 1905–1913, inclusive.

Field.	1905	1906	1907	1908
NIIGATA PREFECTURE.				
Echigo:	*Koku.*	*Koku.*	*Koku.*	*Koku.*
Higashiyama	273,844	304,847	342,042	263,667
Nishiyama	271,495	294,277	360,115	492,393
Niitsu	634,704	808,655	970,556	807,002
Kubiki	97,075	76,578	63,572	62,938
Amaze	5,220	7,262	12,447	.....
Ojiya	14,180	9,964	6,732	7,097
Others (except Formosa)	.....	.....	.....	6,450
Total quantity	1,296,482	1,501,563	1,755,464	1,639,547
Total value	.....	.....	.....	$3,225,153

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Production of petroleum in Japan, 1905–1913, inclusive—Continued.

Field.	1909	1910	1911	1912	1913
	Koku.	*Koku.*	*Koku.*	*Koku.*	*Koku.*
Akita	3,194	12,924	25,090	31,365	76,830
Hokkaido	2,169	1,892	1,358	5,038	4,218
Nagano	64	61	55	.....	.....
Niigata	1,648,678	1,502,807	1,500,482	1,419,539	1,610,117
Shizuoka	2,931	2,637	2,229	2,030	1,983
Yamagata	.....	135	356	205	336
Kagoshima	.....	.....	23	.....	.....
Others	.....	.....	.....	113	98
Total	1,657,036	1,520,458	1,529,593	1,458,290	1,693,582
Formosa	5,664	3,208	1,442	3,040	15,933
Total	1,662,700	1,523,664	1,531,035	1,461,330	1,709,515

Production of petroleum in Japan and Formosa, 1906–1913.

Year.	Japan.		Formosa.		Total.	
	Koku.	*Barrels.*	*Koku.*	*Barrels.*	*Koku.*	*Barrels.*
1906	1,501,563	1,705,776	4,394	4,992	1,505,957	1,710,768
1907	1,755,464	1,994,207	a 6,717	7,631	1,762,181	2,001,838
1908	1,815,001	2,061,841	7,310	8,304	1,822,311	2,070,145
1909	1,657,036	1,882,393	5,664	7,170	1,662,700	1,889,563
1910	1,520,458	1,727,240	3,208	4,062	1,523,664	1,730,882
1911	1,529,593	1,737,618	1,442	1,638	1,531,035	1,739,256
1912	1,458,290	1,656,617	3,040	3,454	1,461,330	1,660,071
1913	1,693,582	1,923,909	15,933	18,100	1,709,515	1,942,009

a Estimated.

PHILIPPINE ISLANDS.

The following information is taken from the report on the mineral resources of the Philippine Islands for 1912:

Interest in the petroleum field on Bondoc Peninsula continues unabated, but no further drilling exploration has been undertaken. This district has 3 shallow wells, 2 on Bahay River (depths 40 and 100 meters), and 1 on Vigo River (depth 21 meters). All 3 wells encountered oil in small quantities.

The known oil seeps in Cebu (Toledo and Algeria on the east coast) are under the control of a local business firm (Messrs. Smith Bell & Co.), but, except the 2 wells drilled at Toledo before the American occupation, no development has been attempted.

Traces of oil on the island of Palawan were reported recently, but the exact situation of the seeps is unknown. Likewise, reports of oil in the northern part of Leyte have been received without more detailed information. Messrs. Smith Bell & Co. undertook to investigate further reported occurrences of petroleum in northern Leyte in 1896, but the insurrection of that year put an end to that work before it was completed. Their engineer stated that he found petroleum in clay or shale, but had no opportunity for a thorough examination. Petroleum seeps are indicated on Spanish maps between the towns of Villaba and San Isidro on the northwest coast of Leyte.

Several samples of gilsonite, a mineral pitch, have been submitted to the Bureau of Science recently. This material also comes from the northern part of the island of Leyte near the town of Leyte. The gilsonite occurs in a bed about 1 meter thick, the outcrop of which is exposed for 6 meters along a small stream, according to the statement of the prospector, and is overlain by sandstone in a series of strata made up principally of blue shale or clay.

A well drilled in search of water at Janiuay, Iloilo, where petroleum and natural gas have been reported in the past, encountered a small flow of natural gas with salt water in a bed of sand and gravel at a depth of 542 meters. Small films of oil come up on the water with the gas, but may represent lubricants from joints of the steel well casing. Gas issues from the well constantly but without violence, accompanied by intermittent flows of salt water.

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The Janiuay well penetrates a sedimentary series—clay, shale, and coarse sands. A well drilled recently at Oas, Albay, encountered inflammable gas at a depth of 120 meters. Oas is situated in an extensive area of alluvium, and the gas in this well is probably marsh gas from plant remains in the buried alluvium. Wells in alluvial deposits at various places have encountered small flows of inflammable gas which are believed to be marsh gas.

Early in 1914 oil seepages were examined at Toledo, Cebu, and a company is reported as formed for exploiting the region.

NEW ZEALAND.

There was great activity in oil exploration in New Zealand, which, besides the formation of new oil-producing companies, included the erection of a refinery at New Plymouth, North Island, capable of refining about 500 barrels a day—a good index of the present yield of the field. The Taranaki and East Coast Oil Properties (Ltd.) and the Kotuku Oil Fields Syndicate are new companies formed to exploit the Taranaki fields and the East Coast. The Royal Dutch group is also investigating the region.

A good flowing well was obtained by a local company at Blenheim near the end of 1913.

The region has been thoroughly described in a volume by J. D. Henry.

AFRICA.

EGYPT.

The drilling of unusually large wells in Egypt during 1913 and the development of a refinery close to Suez serve to emphasize the importance of these Red Sea fields, which have been described in previous reports. These fields have awakened great interest in oil indications in that part of the world. The importance of the region is well pointed out in the Petroleum World.[1]

SOMALILAND.

Sufficient indications of petroleum have been found by British geologists in Somaliland, East Africa, to justify investigations with a view to development.

SOUTH AFRICA.

Crude oil.—The prospect of obtaining oil in South Africa has been rendered much more definite by the careful investigation of Mr. E. H. Cunningham-Craig. He finds that, up to the present, the search for oil has been chiefly directed by such deceptive surface indications as "oils naturally distilled by the heat of intrusions, marsh gas, ferric hydroxide films, salt pans, and various other phenomena, even less pertinent."

These so-called indications have led away the prospector from any chance of achieving the desired result, and considerable capital has unfortunately been sunk in propositions which never from the first

[1] Petroleum World, London, May, 1914, p. 1.

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have had the remotest prospect of success and which would never have been attempted had experienced scientific advice been obtained. The first real prospecting for petroleum in the Union has yet to be undertaken. Mr. Cunningham-Craig concludes that the Karroo System is the one hope for an oil field.

In the Stromberg Series in Cape Colony, Natal, and Basutoland, the essential conditions are fulfilled. In the Transvaal and Natal, lower horizons (Beaufort Series) also furnish sufficient raw material and even in the Dwyka Shales a certain quantity of the necessary carbonaceous matter, of what origin it is unnecessary to inquire, has been proved to exist in many localities. The conditions of deposition necessary are a thick series of strata formed of alternations of porous and impervious groups of rock formation. The absence of igneous intrusions is also to be desired. These conditions are not fulfilled as well as could be wished in any part of the Union, owing to earth movements having been too slow and regular during the deposition of the Karroo System, and the fact that igneous intrusions of post-Karroo age are very widespread.

Favorable geological structure is found only in Cape Colony, and there only in a narrow strip at the southern edge of the Karroo. There is, however, a possibility that northeastern Natal in areas he was unable to visit might furnish favorable structures.

The folded belt of the Karroo System contains excellent anticlinal and dome structures beyond the southern margin of the area characterized by igneous intrusions, and so far as he has been able to ascertain no prospecting for petroleum has been done in that region. The prospects, it must be admitted, are not very hopeful. Only the lower part of the System is involved in the folded belt, and as the carbonaceous contents of the strata seem to decrease perceptibly to the southwest, the quantity of raw material can not be large. Yet even on its southern outcrop the White Band of the Dwyka contains a fair percentage of carbonaceous matter, sufficient in some localities to have admitted of its igniting spontaneously and burning. Impervious beds to act as a cover for any oil that may be beneath the surface are present in quantity in the Ecca Shales, but the presence of a sufficiently porous reservoir rock is problematical. Thus at the best, the conditions are not favorable for large productions. But before abandoning hope of striking petroleum in the Union, it might be as well to make some investigations in this folded belt.

On both theoretical and practical grounds Mr. Cunningham-Craig recommends that the area south of Aberdeen, near Jansenville, Saxony, and Klipplaat station should be examined. Carbonaceous beds in the lower strata must be looked for, and any porous rocks which may be present. If well-marked anticlined or elongated dome structures can be discovered in this area, the well-marked anticline or dome farthest north should be selected, where the White Band of the Dwyka is not less than 1,500 feet beneath the surface, and a well should be drilled to test the series as far as the White Band or even lower.

Though it is by no means certain that petroleum will be discovered such a well if successful will open up a wide area, and if unsuccessful will set at rest all hopes of striking oil in the Union.

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A small production of oil will pay in South Africa, and, even if oil be not struck, it is quite possible that natural gas may be discovered under sufficient pressure to prove a valuable commercial asset.

Though the district near Jansenville and Klipplaat is here selected as being on the railway and easily accessible, it must be remembered that it is on the detailed geological work and its results that the area for testing must be selected. The composition of the Dwyka Beds must be one of the first considerations, and unless it appears that (1) sufficient carbonaceous matter is present, and (2) that the structures are suitable, some other district should be selected.

Natural gas.—There are areas in both the Transvaal and Natal, in the "Coal Measures," where natural gas can be found in fair quantity and might be utilized with profit. It will probably be found only beneath dolerite sheets, since thick impervious shale bands are rare. It is not probable, however, that supplies of gas under pressure sufficient to supply towns at a distance from the gas fields are likely to be found, but the gas may be made a source of profit locally. Gas wells should not be drilled within 600 yards of one another. In the neighborhood of Gruisfontein, Heidelberg District, further prospecting for gas is likely to be successful at comparatively shallow depths.

In the folded belt of the Karroo System the striking of gas in greater or less quantity is probable. A prospecting well for oil will serve the purpose of prospecting for gas also; hence it is not necessary to enlarge upon the point.

Oil shales.—In dealing with oil shales it must be remembered that in the Scottish shale fields great variations in quality are frequent in any seam, and it is not to be expected that shale seams in South Africa are likely to be free from similar variations. It has been found, however, that earth movements have affected shales prejudicially in Scotland. The almost entirely undisturbed state of the strata in South Africa should make the oil shales free from that source of deterioration. In Scotland 130 gallons a ton of shale (from torbanite mineral) is the greatest yield that has been obtained, but many shales are worked that yield no more than 20 or 22 gallons a ton; 18 to 22 pounds of ammonium sulphate a ton is considered a good yield.

Seams need not be very thick to be worth working if the yield of oil be good. In Scotland a 17-inch seam was worked together with a 2-foot seam of coal at Broxburn. The "Grey Shale" at Addiewell was 1 foot 8 inches in thickness, and the "Wee Seam" at Oakbank 2 feet thick, and immediately above the Levensent limestone a seam of 11 inches was worked. Thin seams, however, are not worked now. The crude oil always gives a considerable "loss in refining." These details are given to enable a comparison to be made with the South African shales.

In considering the prospects of the mining and distillation of oil shale the points to be noted specially are (1) accessibility of the area, (2) proximity to markets, (3) cost of mining, and (4) prices ruling in the nearest markets.

Though none of the shales examined, with the exception of that at Kikvorschfontein, are comparable with the best Scottish oil shales, the laboratory tests that have been made prove that very fair quan-

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tities of shale oil can be produced. Laboratory tests, however, are not exactly what is required; commercial tests on a large scale are absolutely necessary if we are to obtain an accurate idea of the value of the various seams.

The seams are unfortunately thin as a rule, and this will greatly increase the mining cost per ton. But against this must be placed the facts that the demand for oils in South Africa is large, that prices ruling at present are very high, and that freight charges are high also. Thus a shale too thin to be worked at a profit in many countries might prove very profitable to work in South Africa.

Mining will be a simpler matter in all the localities visited, and a 3-foot seam with good roof and floor should not cost more than 6s. or 7s. per ton to mine. To be on the safe side, 8s. may be taken as the cost per ton—an outside figure. Then, if as much as 20 gallons a ton can be obtained, a profitable industry is in sight. But yields considerably greater than 20 gallons of oil a ton may be expected. In addition, ammonium sulphate may be another source of profit. In England the crude sulphate sells at from £12 to £14 a ton, and it will doubtless be more expensive in South Africa, where there should be a considerable demand for it as a fertilizer. The recovery of this product will necessitate the making of sulphuric acid, which is very expensive to import, but the oil refining will require sulphuric acid in any case.

In dealing with thin seams, the mining costs per ton will, of course, be high (though 8s. per ton should not be exceeded), but the refining costs will be the same and the quantity of oil per ton may be greater.

The Kikvorschfontein, Mooifontein, Waaihoek, and Hlatimbe-Umkomaas areas should all be considered in this connection. Especial attention is called to the last of these, as it lies within 100 miles of Durban. It seems probable that these shale deposits may be found within 8 or 10 miles of a new railway line to Himeville, which has been projected. It is possible that much of the heavier oils might suit admiralty purposes as fuel oil, and the area nearest to the seaboard is obviously marked out as that which should supply liquid fuel. There is at present a considerable demand for oil for naval purposes, and requirements have recently been altered to admit of the use of oils with a sulphur percentage as high as 3.

Mr. Cunningham-Craig is of opinion that prospecting the folded belt of the Karroo System for crude petroleum and natural gas is of less importance than the development of the mining and refining of shale, and may therefore be relegated to a secondary place. All the evidence to hand at present leads to the belief that an oil-shale industry has good prospects of proving successful in South Africa, and he urges that no effort should be spared to insure a fair test of its possibilities.

ANALYSES OF PETROLEUM FROM VARIOUS PARTS OF THE UNITED STATES.

GENERAL STATEMENT.

The following tables have been compiled from all accessible publications in order to furnish a ready means of comparison of the various crude petroleums in the United States. They are based primarily on the compilation by J. P. Dunlop, of the United States Geological

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Survey, of the analyses recorded in the following publications up to and including 1907:

Publications of the United States Geological Survey.
The State geological survey reports and bulletins of New York, Pennsylvania, West Virginia, Ohio, Kentucky, Tennessee, Indiana, Illinois, Kansas, Louisiana, Texas, Colorado, Wyoming, and California.
"Mineral Industries" volumes of the Tenth and Eleventh censuses.
Transactions of the American Institute of Mining Engineers.
American Journal of Arts and Sciences from 1850 to 1907.
Journal of the American Chemical Society.
American Chemical Journal, 1878 to 1907.
Journal of the Franklin Institute, 1840 to 1907.
Journal of the Chemical Society, 1859 to 1907.
Journal of the Society of Chemical Industry.
Philosophical Magazine.
Chemical News.

This compilation was published in Mineral Resources of the United States for 1907. Subsequently, many analyses have been made in the United States Geological Survey and have been published in various official bulletins, the volumes of Mineral Resources, etc. Many others have been made in the course of the studies of various oil fields and have not been published.

For convenience of access and comparison, these analyses have all been combined and arranged geographically.

The degrees of accuracy and the methods of expressing the results differ greatly in the analyses gathered from the general literature of the subject. In arranging the analyses effort has been made to show the variation in specific gravity, in percentage of sulphur, of asphalt, and of paraffin, and in distillation products. Other analytical data are given under "Remarks."

On the whole, the tables are very incomplete and show clearly the necessity for much additional work. The analyses cited show very full work in some fields and almost nothing in others. In Pennsylvania, New York, Ohio, Indiana, and the newer fields information is lacking as to even the exact locality from which many of the samples came and the conditions under which any particular specimen was obtained. Usually there is no statement as to care used in avoiding evaporation from the sample. Up to 1897 the analytical methods of the older analysts varied to such an extent that as much as 30 per cent difference in the proportion of naphtha will be shown in two samples from the same region, and thus a far greater difference will be shown between two samples from the same pool, as analyzed by the older analysts, than between the oils from widely separated districts. Yet there are no explanatory statements to make these differences intelligible. No more conclusive argument could be offered for the need of a general review of the analytical characteristics of all American oils.

This need was recognized by sending David T. Day, of the Geological Survey, to the Third International Petroleum Congress, held at Bucharest, Roumania, in 1907, where he aided in organizing for the first time an international commission for establishing uniform methods of examining crude petroleum and its products. This international commission considered, during the week in which the Congress was held, the various methods used by different authorities and formulated and recommended to the congress for international adoption

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a provisional system of analysis. This system was adopted by the congress and it was recommended to the various nations for general adoption pending any modifications which might be made by an international commission which this congress created for this purpose. This action was reported to the Congress of the United States in response to a resolution of the Senate, and the rules for analysis were printed as a Senate document.[1]

Since 1907 this international commission has held two general sessions, one in London in 1909 and one in Vienna in 1910. At each of these meetings the system adopted at Bucharest was confirmed, with slight additional rules designed to increase accuracy, the fundamental system remaining fixed.

With this uniform system as its basis, the United States Geological Survey in cooperation with various State geologists immediately began the collection of samples under uniform conditions from the various fields of the United States. These have been examined by exactly the same methods in order that they may be entirely comparable. The work is limited to crude oils, so that these various natural oils may be classified and be made to show their relations to the rocks in which they occur. The study of the composition of the products manufactured from them, as well as the processes by which they are refined, has been left to the Bureau of Mines. A collection, complete at that time, was made of the oils of the Mid-Continent field, including Kansas, Oklahoma, Caddo, and north Texas. The samples were collected at the wells by members of the Survey. Average specimens were also collected in each field from pipe-line tanks, because this showed the actual average, in which the largest wells were given fairer weight than by an arithmetical average of large and small wells. Efforts were made, in collecting these samples from pipe lines, to select those in which the oil had had chance to be well mixed. The samples were, therefore, as representative as possible. The samples from Illinois and other States were similarly collected by members of the Federal or State surveys.

METHOD OF ANALYSIS.

Gravity.—A set of very delicate specific gravity spindles was made especially for this investigation by C. Tagliabue & Sons. The samples are brought to a temperature of 60° F. in a cylinder cooled in a water bath. The specific gravity is then taken, and the tables show also the conversion of this figure into degrees Baumé.

Distillation.—The samples are then distilled by Engler's method as modified by Ubbelohde and adopted by the international commission. Thus 100 cubic centimeters of the crude oil, measured at 60° F., are delivered by a pipette into a distilling bulb holding about 125 cubic centimeters. The dimensions of this bulb are those prescribed by Engler; the length of neck, position of side tube, etc., are exactly given. The thermometer used is a nitrogen thermometer, reading to 550° C., which has been carefully standardized by the United States Bureau of Standards. The condenser tube, as prescribed by Engler,

[1] S. Doc. No. 469, 60th Cong., 1st sess., 1908.

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is 75 centimeters long and has an inclination of 75 degrees from the horizontal. The point of initial boiling is taken when the first drop of oil fell from the condenser tube into the receiving flask. To avoid loss by evaporation the condenser tube is ground to fit into the graduated receiving flask, which is provided with a stop cock to draw off the oil at 150° C. and again at 300° C. Note is also taken of the proportions boiling within each range of 25° C., but these details are not published in the tables given herewith. The fraction between the initial boiling point and 150° C. (302° F.), constituting the gasoline fraction, and the fraction between 150° and 300° C. (302° and 572° F.), constituting the kerosene fraction, are examined as to specific gravity with a picnometer. The residuum is weighed as soon as cool; then its specific gravity is taken in the usual way and the volume calculated. As will be noted, the total thus obtained for the different fractions includes the sum of all variations in the determinations. This total for many samples slightly exceeds 100 per cent, due to errors in coefficient of expansion, etc., but for a greater number is considerably below that amount, owing to the presence of water, loss of volatile gasoline, etc.

Unsaturated hydrocarbons.—The method of Kramer and Bottcher is used for determining the unsaturated hydrocarbons present in the crude oil and in the distillate between 150° C. and 300° C. The quantity of gasoline in many samples was too small for systematic determination of the percentage of unsaturated hydrocarbons in it. The method consists in shaking 25 cubic centimeters of the crude petroleum with 25 cubic centimeters of sulphuric acid of specific gravity 1.83, corresponding to ordinary strong sulphuric acid, about the equivalent of that used in petroleum refining. The acid and oil are shaken in a small flask with a long neck, the neck holding 25 cubic centimeters. The flask is then filled with strong sulphuric acid until the oil which remains uncombined with the acid can be measured in the neck of the flask. The loss in volume between the original 25 cubic centimeters and the oil which remains undissolved by sulphuric acid is taken to represent the unsaturated hydrocarbons.

Paraffin wax.—This was determined by the Engler Holde method. Two parts of absolute alcohol and one part of absolute ether are used as the solvent, from which the paraffin wax is precipated on cooling to −20° C.

Asphalt.—The asphalt was determined by Holde's method, by weighing off 1 gram of residuum and shaking this with 40 cubic centimeters of gasoline which was free from unsaturated hydrocarbons and which boiled between 65° and 95° C. After shaking this is allowed to stand for 48 hours and the precipitated asphalt is dissolved in benzol, dried at 105°, and weighed. Accuracy greater than 1 per cent is not claimed for these analyses.

Sulphur.—The sulphur is sometimes determined by Burton's method of burning in a lamp and collecting the SO_2 and H_2SO_4 in a solution of Na_2CO_3 and titrating with methyl orange and sometimes by the bomb. When both methods are used on the same sample the results are consistent.

No attempt has been made in these tables to continue the compilation of analyses of other authorities since 1907.

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Refinery analytical methods.—It may be well to note that the analyses made in refineries are intended not for comparative purposes but as a guide to what can be obtained, in the sort of still employed in that refinery, of products for which that refinery has a market at that time. Therefore instead of defining the gasoline yield as the product which distills over up to 150° C., the refiner includes in the gasoline or "crude naphtha" cut, all of the distillate which is lighter than a certain gravity. This gravity varies with his trade. When, however, they wish to compare crude oils from various sources, these refiners are coming to use the international system more and and more generally.

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Analyses of petroleum from various parts of the United States.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	ALASKA.								
1	Katalla Bay		Well	10		0.8280	39.1		
2	Katalla		do	10		.7958	45.9		
3	Do		do	10		.8000	45.0		
4	Cold Bay		Seepage			.9547	16.6	Dark green	
5	Oil Bay		do			.9557	16.5	do	
	CALIFORNIA.								
6						.8348	37.7	Dark brown opaque.	
7	Alameda County; Alisol Oil Co		Tank			.8766	29.7	Brown	
8	Alameda County	Robert Anderson				.8850	28.2	Black	
9	Colusa County					.8257	39.6	Yellow	
10	Do					.9835	12.3		
11	Do					.9534	16.8		
12	Do					.9535	15.3		
13	Contra Costa County					.9667	14.8	Black	
14	Fresno County: Coalinga		Tank, Oil City			.8568	33.4	Green	

1. U. S. Geol. Survey Bull. 225, 1904. Penniman and Browne, analysts.
2. U. S. Geol. Survey Mineral Resources, 1902, p. 583, 1903.
4–5. U. S. Geol. Survey Bull. 250, p. 121, 1905. Penniman and Browne, analysts.
6. Am. Chem. Soc. Jour., 1891. D. Woodman.
9. Am. Chem. Soc. Jour., vol. 25, p. 669. Edmond O'Neill.
10. California State Min. Bur. Bull. 19. M. L. Watts.
11. California State Min. Bur. Bull. 19.
12. U. S. Geol. Survey Mineral Resources, 1903, p. 178, 1904. Paul W. Prutzman, analyst.
13. Am. Chem. Soc. Jour., vol. 25, p. 669. Edmond O'Neill.
14. California State Min. Bur. Bull. 31.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.).	By volume.												
			To 150° C.		150°-300° C.		Residuum.		Total.							Crude	150°-300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.						
	ALASKA.														
1	Katalla Bay	.....	21.0	0.7573	51.0	0.8204	28.0	.....	100.0	.....	.....	.....	.....	.....	.....	Residuum paraffin base.
2	Katalla	.....	38.5	.....	31.0	.....	30.5	.....	100.0	Tr.	.....	.....	.....	.....	.....	Residuum all over 285° C.; cold test—did not chill at 3° F.
3	Do	.....	34.2	.....	34.4	.....	31.0	.....	99.6	.....	.....	.....	.....	.....	.....	
4	Cold Bay	225	.....	.....	13.3	.8772	86.7	.....	100.0	0.116	.....	.....	.....	.....	.....	86.7 p. ct. residuum includes 8.1 p. ct. coke and loss and products distilled under 120 mm. pressure up to 350° C., and also products by destructive distillation.
5	Oil Bay	230	.....	.....	13.2	.8777	86.8	.....	100.0	.095	.....	.....	.....	.....	.....	86.8 p. ct. residuum includes 5.6 p. ct. coke and loss and products distilled under 120 mm. pressure up to 350° C., and also products by destructive distillation.
	CALIFORNIA.														
6	.....	.....	10.0	.730	40.0	.....	50.0	.....	100.0	.....	.....	.....	.....	.....	.....	Lubricating oil, 40 p. ct.; residuum, 10 p. ct.
7	Alameda County; Alisol Oil Co.	175	.....	.....	48.0	.8279	52.0	0.9272	100.0	.....	5.4	0.9	.....	.....	.....	
8	.....	160	.....	.....	47.0	.8202	53.0	.9504	100.0	.....	.....	.....	.....	.....	.....	
9	Colusa County	.....	.....	.....	[a]77.8	.....	.....	.....	.....	.....	.....	0.50	.....	.....	.....	[a] 150°-350° C.
10	Do	.....	0.0	.....	16.25	.9111	83.75	.....	100.0	.....	.....	.....	.....	.....	.....	Sample contained sludge.
11	Do	.....	Tr.	.....	[a]21.6	.8533	78.4	.....	100.0	.....	.....	.....	.....	.....	.....	300°-350° C., 3 p. ct. Sample contained sludge.
12	Do	.....	0	.....	[a]19.0	.....	81.0	.....	100.0	.....	.....	.....	.....	.....	.....	[a] 150°-270° C. Maumene No. 0.806.
13	Contra Costa County	.....	3.7	.....	[a]54.5	.....	42.8	.....	101.0	.....	.....	21.0	.....	.....	.....	[a] 150°-350° C.
14	Fresno County: Coalinga	.....	(a)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Gasoline, 2.3 p. ct.; engine distillate, 22.3 p. ct.; kerosene, 28.6 p. ct.; stove oil, 10.3 p. ct.; gas oil, 9.9 p. ct. [a] Temperature not given.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Fresno County—Continued.								
15	Coalinga		Tank, top sand oil.			0.8974	26.0	Black	
16	Do		Pipe line			.9296	20.6		
17	Do		Pipe line, Ora crude.			.9321	20.2		
18	Do					.8537	34.0		
19	Do					.8521	34.3		
20	Do					.9880	11.7		
21	Coalinga; M. K. & T. Oil Co					.9589	16.0		
22	Coalinga								
23	Do		Spring			.9743	13.7		
24	Do					.7609	54.0		
25	Do					.9028	25.1	Brown	
26	Do					.9511	17.2	do	
27	Do					.9320	20.2	do	
28	Do					.8459	35.5	Greenish	
29	Coalinga; California Oilfield, Ltd		Well	2	1,020	.9150	23.0		
30	Do		do	11	1,125	.9679	31.3		
31	Coalinga		do	R. C. Baker	590	.9756	13.5		

15–17. California State Min. Bur. Bull. 31.
18. California State Min. Bur. Bull. 19, p. 204.
19–20. California State Min. Bur. Ann. Rept. 1894, p. 352.
21. U. S. Geol. Survey, from card reporting production, 1905.
22. U. S. Geol. Survey Mineral Resources, 1897, p. 100, 1898.
23. California State Min. Bur. Bull. 3, p. 90.
24. U. S. Geol. Survey Mineral Resources, 1896, p. 845, 1897. **Frederick Salathe, analyst.**
25–27. Am. Chem. Soc. Jour., vol. 25, p. 669. Edmond O'Neill.
28. Am. Chem. Jour., vol. 19, p. 802. Charles F. Mabery.
29–31. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 140° C.		150°-300° C.		Residuum.		Total.					Crude	150°-300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	CALIFORNIA—continued.															
	Fresno County—Continued.															
15	Coalinga	.....	(a)	.....	.....	.....	.....	.....	.....	.....	.....	17.0	.....	.....	.....	Gasoline, benzine, and distillate, 12.38 p. ct.; kerosene and stove oil, 30.30 p. ct. a Temperature not given.
16	Do	.....	(a)	.....	.....	.....	.....	.....	.....	.....	.....	13.34	.....	.....	.....	Gasoline and benzine, 3.89 p. ct.; kerosene and stove oil, 13.35 p. ct. a Temperature not given.
17	Do	.....	(a)	.....	.....	.....	.....	.....	.....	.....	.....	22.7	.....	.....	.....	Engine distillate, 4.34 p. ct.; kerosene, 41.3 p. ct. a Temperature not given.
18	Do	.....	32.6	0.800	43.6	0.8372	23.8	.....	100.0	.....	.....	.....	.....	.....	.....	300°-350° C., 12 p. ct., sp. gr. 0.9091.
19	Do	.....	32.6	.800	a44.2	.8488	23.2	.....	100.0	.....	.....	.....	.....	.....	.....	a 150°-250° C.; 250°-320° C., 12 p. ct., sp. gr. 0.911.
20	Do	.....	0	.....	a 8.5	.....	91.5	.....	100.0	.....	.....	.....	.....	.....	.....	a Up to 320° C.
21	Coalinga, M. K. & T. Oil Co.	.....	0	.....	14.5	.....	85.5	.....	100.0	.....	.....	9.5	.....	.....	.....	
22	Coalinga	.....	18-20	.....	47-48	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Heavy fuel oil, 10 to 13 p. ct.
23	Do	.....	0	.....	a 3.3	.820	96.7	.....	100.0	.....	.....	.....	.....	.....	.....	a Up to 320° C.
24	Do	49	30.0	.....	b60.0	.....	10.0	.....	100.0	.....	.....	10.0	.....	.....	.....	a 49°-141° C.; b 141°-275° C. Residuum hard asphalt.
25	Do	.....	18.0	.....	a48.7	.....	33.3	.....	100.0	.....	.....	16.2	.....	.....	.....	a 150°-320° C.; 320° C. to asphalt, 18 p. ct.
26	Do	.....	.8	.....	a57.5	.....	41.7	.....	100.0	.....	.....	25.4	.....	.....	.....	a 150°-320° C.; 320° C. to asphalt, 14.8 p. ct.
27	Do	.....	1.1	.....	a62.4	.....	36.5	.....	100.0	.....	.....	14.6	.....	.....	.....	a 150°-320° C.; 320° C. to asphalt, 21.50 p. ct.
28	Do	.....	33.06	.7829	57.85	.8608	9.09	.....	100.0	0.21	.....	.....	.....	.....	.....	Combustion gives carbon 86.24 p. ct.; hydrogen, 13.08 p. ct.; bromine absorption, 9.07 p. ct.
29	Coalinga; California Oilfield, Ltd.	.....	5.7	.7716	34.1	.8582	60.2	.....	100.0	.45	.....	.....	.....	.....	.....	Calorific value per c. c., 9,726. Viscosity by Redwood viscometer, 172 at 15° C., 37 at 85° C.
30	Do	.....	24.2	.7317	38.3	.8473	37.5	.....	100.0	.38	.....	9.1	.....	.....	.....	Calorific value per c. c., 9,321. Viscosity by Redwood viscometer, 56 at 15° C., 32.5 at 85° C.
31	Coalinga	.....	.....	.....	13.7	.8888	86.3	.....	100.0	.78	.....	31.8	.....	.....	.....	Viscosity by Redwood viscometer, 186 at 85° C.; calorific value per c. c., 10,088.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Fresno County—Continued.								
32	Coalinga; Home Oil Co.		Well	Blue Goose No. 3	1,350	0.8530	34.1		
33	Coalinga; 14, T. 20 S., R. 14 E.		....do			.9331	12.4		
34	Coalinga; 24, T. 20 S., R. 14 E.		....do			.9609	15.7		
35	Coalinga; T. 20 S., R. 14 E.		Pipe line			.9562	16.4		
36	Coalinga; sec. 6, T. 20 S., R. 15 E.		Well			.9472	17.8		
37	Coalinga; sec. 31, T. 19 S., R. 15 E.		....do			.9415	18.7		
38	Coalinga; sec. 28, T. 19 S., R. 15 E.		Tank			.9247	21.4		
39	Coalinga; sec. 20, T. 19 S., R. 15 E.		....do			.8568	33.4		
40	Do.		Well			.8000	45.0		
41	Alcade district; sec. 29, T. 18 S., R. 13 E.		....do			.9091	24.0		
42	Vallecitos district.		Spring			.9150	23.0		
43	Do.		Well			.9750	13.6		
44	Oil City-Coalinga.		Tank average			.8542	33.9		
45	Do.					.8000	45.0		
46	Do.					.8584	33.1		
47	Twenty-eight oil district.					.9415	18.7		
48	Do.					.9211	22.0	Dark brown.	

32. California State Min. Bur. Bul. 31. H. N. Cooper, chemist.
33–42. California State Min. Bur. Bull. 31. P. W. Prutzman.
43. California State Min. Bur. Bull. 3, p. 90. Laboratory analysis.
44. California State Min. Bur. Bull. 31, p. 192.
45–48 U. S. Geol. Survey Mineral Resources. 1903, p. 177, 1904. Paul W. Prutzman, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume. To 150° C. Cubic centimeters.	To 150° C. Specific gravity.	150°–300° C. Cubic centimeters.	150°–300° C. Specific gravity.	Residuum. Cubic centimeters.	Residuum. Specific gravity.	Total. Cubic centimeters.					Crude	150°–300°C.	
	CALIFORNIA—continued.														
	Fresno County—Continued.														
32	Coalinga; Home Oil Co.	.....	36.1	0.7973	55.0	0.8760	8.9	.....	100.0	0.06	.....	4.1	.....	.....	.....	Calorific value per c. c., 9,040; viscosity by Redwood viscometer, 28.5 at 15° C., 2.55 at 85° C.
33	Coalinga; 14, T. 20 S., R. 14 E.	.....	0	.....	a 0	.....	34.8	.....	100.0	.....	.....	34.8	.....	.....	.....	a 150°–270° C.; above 270° C., 65.2 p. ct.
34	Coalinga; 24, T. 20 S., R. 14 E.	.....	0	.....	a 5.8	.8594	94.2	.....	100.0	.....	.....	27.9	.....	.....	.....	a 150°–270° C.; above 270° C., 64.5 p. ct.
35	Coalinga; T. 20 S., R. 14 E.	.....	0	.....	a 6.5	.8563	93.5	.....	100.0	.....	.....	21.7	.....	.....	.....	a 150°–270° C.; above 270° C., 70 p. ct.
36	Coalinga; sec. 6, T. 20 S., R. 15 E.	.....	0	.....	a18.3	.8495	81.7	.....	100.0	.....	.....	20.1	.....	.....	.....	a 150°–270° C.; above 270° C., 58.6 p. ct.
37	Coalinga; sec. 31, T. 19 S., R. 15 E.	.....	0	.....	a15.0	.8573	85.0	.....	100.0	.....	.....	22.1	.....	.....	.....	a 150°–270° C.; above 270° C., 62.4 p. ct.
38	Coalinga; sec. 28, T. 19 S., R. 15 E.	.....	1.0	.....	a25.0	.8353	74.0	.....	100.0	.....	.....	15.2	.....	.....	.....	a 150°–270° C.; above 270° C., 54 p. ct.
39	Coalinga; sec. 20, T. 19 S., R. 15 E.	.....	28.0	.7928	a50.0	.861	22.0	.....	100.0	.....	.....	Tr.	.....	.....	.....	a 150°–270° C.; above 270° C., 21 p. ct.
40	Do	.....	52.0	.7701	a27.0	.806	21.0	.....	100.0	.....	.....	0	.....	.....	.....	a 150°–270° C.; above 270° C., 18 p. ct.
41	Alcade district; sec. 29, T. 18 S., R. 13 E.	.....	1.0	.....	a33.0	.8388	66.0	.....	100.0	.....	.....	6.6	.....	.....	.....	a 150°–270° C.; above 270° C., 57.9 p. ct.
42	Vallecitos district	.....	10.7	.7568	a31.0	.8314	58.3	.....	100.0	.....	.....	21.3	.....	.....	.....	a 150°–270° C.; above 270° C., 35.9 p. ct.
43	Do	.....	.....	.....	a10.4	.886	89.6	.....	100.0	.....	.....	.....	.....	.....	.....	a Up to 320° C.
44	Oil City-Coalinga	.....	11.4	.7521	a35.8	.813	52.8	.....	100.0	.....	.....	.....	.....	.....	.....	Residue liquid.
45	Do	.....	52.0	.....	a27.0	.....	21.0	.....	100.0	.....	.....	0	.....	.....	.....	a 150°–270° C.
46	Do	.....	28.0	.....	a50.0	.....	22.0	.....	100.0	.062	.....	.....	.....	.....	.....	a 150°–270° C.; above 270° C., 22 p. ct.; nitrogen, 0.063 p. ct.
47	Twenty-eight oil district	.....	1.0	.....	a18.0	.....	81.0	.....	100.0	.....	.....	20.0	.....	.....	.....	a 150°–270° C.; above 270° C., 61 p. ct. Oil at 19° C., nitrogen, 0.314 p. ct.
48	Do	69.5	6.0	.....	a26.0	.....	68.0	.....	100.0	.817	.....	15.0	.....	.....	.....	a 150°–270° C.; above 270° C., 53 p. ct. Viscosity by Engler instrument, 30, oil at 22° C.; nitrogen, 0.302 p. ct.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Fresno County—Continued.								
49	Southwest district					0.9472	17.8		
50	Do					.9582	16.1	Black	
51	Fresno, San Benito					.9050	24.7		
52	Do					.8589	33.0		
53	Do					.9150	23.0		
54	Humboldt County					.9518	17.1	Yellow	
55	Do					.8973	26.0	....do	
56	Do					.9014	25.3	....do	
57	Do					.8810	28.9	Red brown	
58	Do					.8263	39.4	Yellow	
59	Do					.7854	48.3		
60	Mattole					.8163	41.5	Bright green	
	Kern County:								
61	Kern River					.9622	15.5		
62	Do		Tank average			.9622	15.5		
63	Kern River; sec. 8, T. 29 S., R. 28 E		Well			.9972	10.4		

49–53. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman, analyst.
54–59 Am. Chem. Soc. Jour., vol. 25, p. 660. Edmond O'Neill.
61. California State Min. Bur. Bull 31. Paul W. Prutzman, chemist.
62. California State Min. Bur. Bull. 19. Thos. Price & Son, analysts.
63. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.								
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	CALIFORNIA—continued.														
	Fresno County—Continued.														
49	Southwest district		0		[a]18.0		82.0		100.0	0.874		22.0				[a] 150°–270° C.; above 270° C., 60 p. ct. Nitrogen, 0.299 p. ct.
50	Do		0		[a]7.0		93.0		100.0			21.0				[a] 150°–270° C.; above 270° C., 72 p. ct. Nitrogen, 0.375 p. ct.
51	Fresno, San Benito		8.0		[a]31.0		61.0		100.0			16.0				[a] 150°–270° C.; above 270° C., 45 p. ct.
52	Do		20.0		[a]25.0		55.0		100.0			5.0				[a] 150°–270° C.; above 270° C., 50 p. ct.
53	Do		11.0		[a]31.0		58.0		100.0			22.0				[a] 150°–270° C.; above 270° C., 36 p. ct.
54	Humboldt County				[a]16.1		83.9		100.0			26.5				[a] 150°–270° C.; 250°–350° C., 53.60 p. ct.
55	Do				[a]15.7		84.3		100.0			4.9				[a] 150°–250° C.; 250°–350° C., 35.10 p. ct. Viscosity at 15.5° C., 3 (Engler method).
56	Do		13.7		[a]33.4		52.9		100.0			19.4				[a] 150°–250° C.; 250°–350° C., 22.20 p. ct.
57	Do				[a]47.5		52.5		100.0			7.5				[a] 150°–250° C.; 250°–350° C., 35.20 p. ct. Hydrogen, 12.03 p. ct.; carbon; 86.69 p. ct. Viscosity at 15.5° C., 1.57; at 85° C., 1.05 (Englers method).
58	Do		39.5		[a]29.8		30.7		100.0			4.7				[a] 150°–250° C.; 250°–350° C., 24 p. ct. Viscosity at 15.5° C., 1.1; at 85° C., 0.95 (Engler method).
59	Do		32.6		[a]28.2		39.2		100.0			5.0				[a] 150°–250° C.; 250°–350° C., 17.2 p. ct. Viscosity at 15.5° C., 1.17; at 85° C., 0.96 (Engler method).
60	Mattole		28.5	0.7447	[a]42.0	0.7977	29.5		100.0			0.0	9.0			[a] 150°–270° C.; above 270° C., 30 p. ct. Maumene No. 0.03.
	Kern County:														
61	Kern River				10.9	.874	89.1		100.0							300°–350° C., 10 p. ct.; sp. gr. 0.896.
62	Do		[a]									33.0				Run without care to avoid cracking in steam still; products varied. [a] Temperature not given.
63	Kern River; sec. 8, T. 29 S., R. 28 E.						100.0		100.0			31.9				Above 270° C., 65.8 p. ct., sp. gr. 0.9241.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Kern County—Continued.								
64	Kern River; sec. 3, T. 29 S., R. 28 E.		Well			0.9722	14.0		
65	Kern River		Pipe line			.9642	15.2		
66	Kern River; Associated Oil Co		Well	Omar 4	1,052	.9609	15.7		
67	Kern River; King Refining Co		do		850	.9792	13.0		
68	Kern River		Tank			.9655	15.0		
69	Do					.9782	13.1	Black	
70	Do					.9673	14.7	do	
71	Do					.9655	15.0		
72	Midway					.9321	20.2	Black brown	
73	Midway; sec. 22, T. 32, N., R. 23 E.					.9790	13.0		
74	Midway; sec. 17, T. 32 N., R. 23 E.					.9517	17.1		
75	McKittrick					.9480	17.7	Black	
76	Do					.9650	15.1	do	

64–65. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
66–68. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
69, 70. Am. Chem. Soc. Jour., vol. 25. Edmond O'Neill.
71, 72. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman, analayst.
73, 74. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
75, 76. Am. Chem. Soc. Jour., vol. 25. Edmond O'Neill.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.					Crude	150°–300° C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	CALIFORNIA—continued.															
	Kern County—Continued.															
64	Kern River; sec. 3, T. 29 S., R. 28 E.						100.0		100.0			35.2				Above 270° C., 61.1 p. ct., sp. gr. 0.9144.
65	Kern River				a13.0		87.0		100.0			16.2				a 150°–270° C.; above 270° C., 67.5 p. ct., sp. gr. 0.9259.
66	Kern River; Associated Oil Co.		0		20.2	0.8626	79.8		100.0	0.94		21.4				Caloric value per c. c., 9,989. 300° C. to asphalt, 56.5 p. ct. Viscosity at 85° C., 134; at 15.5° C., over 1,800 (Redwood viscometer used).
67	Kern River; King Refining Co.		0		22.5	.8901	77.5		100.0			31.1				300° C. to asphalt, 44.4 p. ct. Viscosity at 85° C., 410; at 15° C., over 1,800 (Redwood viscometer used).
68	Kern River		(a)									38.7				Still run in usual manner in making asphalt and distillate. a Temperature not given.
69	Do				a37.9		62.1		100.0			31.6				a 150°–350° C.; 350 C. to asphalt, 27.2 p. ct. B. t. u., 18,342.
70	Do		1.0		a29.0		71.0		100.0	.98		21.25				a 150°–350° C.; 350° C. to asphalt, 48.13 p. ct. B. t. u., 18,847.8. Viscosity at 15.5° C., 274.35; at 85° C., 3.35.
71	Do				a11.0		89.0		100.0	.612		35.0				a 150°–270° C.; above 270° C., 54 p. ct. Maumene No. 0.341. Oil at 15° C., nitrogen, 0.60 p. ct.
72	Midway		3.0		a24.0		73.0		100.0			20.0				a 150°–270° C.; 270° C. to asphalt, 53 p. ct. Oil at 20° C., nitrogen, 3.74 p. ct.
73	Midway; sec. 22, T. 32 N., R. 23 E.		0		a0		100.0		100.0			36.0				Above 270° C., 61.2 p. ct., sp. gr. 0.9168. a 150°–270° C.
74	Midway, sec. 17, T. 32 N., R. 23 E.				a5.7	.8589	94.3		100.0			36.7				a 150°–270° C.; 270° C. to asphalt, 54.2 p. ct.
75	McKittrick		0		a39.9		60.1		100.0	.87		14.25				a 150°–350° C.; 350° C. to asphalt, 45.82 p. ct. Hydrogen, 11.45 p. ct.; carbon, 86.06 p. ct. B. t. u., 18,675.
76	Do		Tr.		a32.0		68.0		100.0	.87		15.0				a 150°–350° C.; 350° C. to asphalt, 53.25 p. ct. B. t. u., 18,570.6.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Kern County—Continued.								
77	McKittrick					0.9396	19.0		
78	Do					.9655	15.0		
79	McKittrick; sec. 13, T. 30 S., R. 21 E		Pipe line			.9655	15.0		
80	McKittrick; sec. 12, T. 30 S., R. 21 E		Well			.9649	15.1		
81	McKittrick; sec. 20, T. 30 S., R. 22 E		Tank			.9402	18.9		
82	McKittrick		Well			.9396	19.0		
83	McKittrick; Southern Pacific Oil Co		do	5	500	.9425	18.5		
84	McKittrick; Associated Oil Co		do	Shamrock 3	1,377	.9396	19.0		
85	McKittrick; Induna Oil Co		do		900	.9747	13.6		
86	Sunset					.9715	14.1		
87	Do					1.000	9.9		

77, 78. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman, analyst.
79–82. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
83–87. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (C.°)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.						
	CALIFORNIA—continued.														
	Kern County—Continued.														
77	McKittrick		1.0		[a]22.0		77.0		100.0	0.87		21.0				[a] 150°–270° C.; 270° C. to asphalt, 56 p. ct. Maumene No. 0.347. Nitrogen, 0.8 p. ct.
78	Do		0		[a]11.0		89.0		100.0	.565		26.0				[a] 150°–270° C.; above 270° C., 63 p. ct. Maumene No. 0.365. Nitrogen, 0.29 p. ct. (according to Mabery and Hudson). (See Am. Chem. Jour., vol. 25, p. 253.)
79	McKittrick; sec. 13, T. 30 S., R. 21 E.				[a]11.0	0.8568	89.0		100.0			26.9				[a] 150°–270° C.; above 270° C., 59 p. ct.
80	McKittrick; sec. 12, T. 30 S., R. 21 E.				[a]11.4	.8464	88.6		100.0			28.9				[a] 150°–270° C.; above 270° C., 57.4 p. ct.
81	McKittrick; sec. 20, T. 30 S., R. 22 E.		0.5		[a]22.0	.8403	77.5		100.0			22.6				[a] 150°–270° C.; above 270° C., 53 p. ct.
82	McKittrick		.5		[a]22.0	.8299	77.5		100.0			27.6				[a] 150°–270° C.; above 270° C., 48.6 p. ct.
83	McKittrick; Southern Pacific Oil Co.		4.2	0.776	37.8	.8675	58.0		100.0	.77		22.5				[a] 300° C. to asphalt, 35 p. ct. Viscosity by Redwood viscometer at 15° C., 1,100; at 85° C., 54. Calorific value per c. c., 9,804.
84	McKittrick; Associated Oil Co.		4.0	.779	35.1	.8664	60.9		100.0	.76		21.0				300° C. to asphalt, 40.1 p. ct. Viscosity by Redwood viscometer at 15° C., 8,333; at 85° C., 50. Calorific value per c. c., 9,817.
85	McKittrick; Induna Oil Co.				26.7	.8830	73.3		100.0	1.08		23.0	10.0			300° C. to asphalt, 39.3 p. ct. Viscosity by Redwood viscometer at 15° C., over 1,800; at 85° C., 182. Calorific value per c. c., 10,092.
86	Sunset		[a]		12.7	.8589	87.3		100.0			29.3				[a] Temperature not given. Precautions taken against cracking.
87	Do		[a]		2.9	.8589	97.1		100.0							[a] Temperature not given. Sample probably the heaviest from any well in California.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from-	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Kern County—Continued.								
88	Sunset; Western Minerals Co		Well	1	500	0.9846	12.2		
89	Sunset; Alameda Oil Co		....do	1	790	.9816	12.6		
90	Sunset		Pipe line			.9722	14.0		
91	Do		....do			.9504	17.3		
92	Do		Well	No. 2, group 2		.9710	14.2		
93	Do					.9655	15.0		
94	Do					.9504	17.3		
95	Do					1.0000	9.9		
96	Do					.9603	15.8	Black	
97	Do					.9267	21.1	....do	
98	Do		Shallow well			.9784	13.1		

88–89. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
90–91. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
92–93. California State Min. Bur. Bull. 3. Laboratory analyses.
94–95. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul Prutzman, analyst.
96–97. Am. Chem. Soc. Jour., vol. 25. Edmond O'Neill.
98. Pet. Rev., Jan. 5, 1907. Clifford Richardson.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.									
	CALIFORNIA—continued.														
	Kern County—Continued.														
88	Sunset; Western Minerals Co.	.....	.....	.....	27.4	0.8974	72.6	.....	100.0	.....	.....	28.8	.....	.....	.....	300° C. to asphalt, 36.4 p. ct. Viscosity by Redwood viscometer at 15° C., over 1,800; at 85° C., 410.
89	Sunset; Alameda Oil Co.	.....	.....	.....	43.6	.8789	56.4	.....	100.0	0.90	.....	23.5	.....	.....	.....	300° C. to asphalt, 34.5 p. ct. Viscosity by Redwood viscometer at 15° C., over 1,800; at 85° C., 82.5. Calorific value per c. c., 10,173.
90	Sunset	.....	.....	.....	a12.0	.8439	88.0	.....	100	.....	.....	32.0	.....	.....	.....	a 150°–270° C.; above 270° C., 53 p. ct.
91	Do	.....	4.1	.....	a12.3	.8197	83.6	.....	100	.....	.....	24.0	.....	.....	.....	a 150°–270° C.; above 270° C., 57.6 p. ct.
92	Do	.....	.....	.....	a14.0	.893	86.0	.....	100	.....	.....	.....	.....	.....	.....	a Below 325° C.; below 250° C., 1 p. ct.
93	Do	.....	.....	.....	14.2	.8589	85.8	.....	100	.....	.....	.....	.....	.....	.....	300°–350° C., 5.2 p. ct., sp. gr. 0.875.
94	Do	.....	4.0	.....	a12.0	.....	84.0	.....	100	.86	.....	24.0	.....	.....	.....	a 150°–270° C.; above 270° C., 60 p. ct. Nitrogen, 0.476 p. ct.
95	Do	.....	.....	.....	a5.0	.....	95.0	.....	100	1.253	.....	51.0	.....	.....	.....	a 150°–270° C.; above 270° C., 44 p. ct. Maumene No. 0.432. Nitrogen, 0.370 p. ct.
96	Do	.....	.....	.....	a11.9	.....	88.1	.....	100	.86	.....	23.9	.....	.....	.....	a 150°–250° C.; 250°–350° C., 26.40 p. ct.; 350° C. to asphalt, 37.80 p. ct. Nitrogen, 0.047. B. t. u., 18,684.
97	Do	.....	6.50	.....	a17.26	.....	76.24	.....	100	.....	.....	11.0	.....	.....	.....	a 150°–250° C.; 250°–350° C., 17.25 p. ct.; 350° C. to asphalt, 47.98 p. ct.
98	Do	.....	a8.9	0.867	b32.0	.....	59.1	.....	100	.....	.....	.....	.....	.....	.....	Distilled in vacuo 26 mm.; 60°–100° C., 0.9 p. ct. a 60°–145° C. b 145°–270° C.; 190°–220° C., 8 p. ct., sp. gr. 0.9209; 220°–224° C., 8 p. ct., sp. gr. 0.9347; refractive index 1.523; 245°–270° C., 8 p. ct., sp. gr. 0.9621, refractive index 1.526. Other data showing results of treatment with 10 p. ct. solution NaOH and H_2SO_4.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Los Angeles County:								
99	Little Moore Canyon		Well	1		0.9100	23.9		
100	Not located					.9709	14.2		
101	Los Angeles City, Park Street					.9534	16.8		
102	Do					.9520	17.0		
103	Do					.9515	17.1		
104	Do					.9539	16.8		
105	Do					.9528	16.9		
106	Do					.9565	16.4		
107	Do					.9580	16.1		
108	West Los Angeles City		Well	McIntosh		.9816	12.6		
109	Do		do	Maltman		.9702	14.3		
110	East End Field, Los Angeles City, Proudfitt & Parker.		do	2	1,225	.9699	14.4		
111	East End Field, Los Angeles City, Davis & Harrison.		do	10	1,275	.9774	13.2		
112	East End Field, Los Angeles City, Davis & Henderson.		do	Solans	950	.9467	17.9		
113	East End Field, Los Angeles City, Consolidated Crude Oil Co.		do	22	800	.9815	12.6		
114	Knob Hill, Los Angeles City, Los Angeles Rwy. Co.		do	Hubbell 2	1,250	.9558	16.5		

99. California State Min. Bur., 1887. W. D. Johnston, chemist.
100. California State Min. Bur. Bull. 11. Frederick Salathe.
101–109. California State Min. Bur. Laboratory analyses.
110–114. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.									
	CALIFORNIA—continued.														
	Los Angeles County:														
99	Little Moore Canyon	.....	6.6	0.757	26.2	0.8141	67.2	.....	100	.....	.....	.....	.....	.....	.....	150°–200° C., 11.20 p. ct., sp. gr. 0.787; 200°–250° C., 7 p. ct., sp. gr. 0.821.
100	Not located	.....	Tr.	.....	6.0	.....	94.0	.....	100	.....	.....	25.0	.....	.....	.....	Pyridine base equals 3.2 p. ct.
101	Los Angeles City, Park Street.	.....	Tr.	.....	21.6	.8533	78.4	.....	100	.....	.....	.....	.....	.....	.....	300°–350° C., 3 p. ct.
102	Do	.....	Tr.	.....	22.3	.8650	77.7	.....	100	.....	.....	.....	.....	.....	.....	300°–350° C., 7.1 p. ct., sp. gr. 0.889.
103	Do	.....	Tr.	.....	23.2	.8589	76.8	.....	100	.....	.....	.....	.....	.....	.....	300°–350° C., 8 p. ct., sp. gr. 0.8895.
104	Do	.....	Tr.	.....	27.2	.8589	72.8	.....	100	.....	.....	.....	.....	.....	.....	300°–350° C., 5 p. ct., sp. gr. 0.8922.
105	Do	.....	Tr.	.....	20.0	.8441	80.0	.....	100	.....	.....	.....	.....	.....	.....	300°–350° C., 4 p. ct.
106	Do	.....	Tr.	.....	13.0	.8662	87.0	.....	100	.....	.....	.....	.....	.....	.....	300°–350° C., 3.4 p. ct.
107	Do	.....	Tr.	.....	13.4	.8721	86.6	.....	100	.....	.....	.....	.....	.....	.....	300°–350° C., 7 p. ct., sp. gr. 0.8820.
108	West Los Angeles City	.....	Tr.	.....	1.6	.....	98.4	.....	100	.....	.....	.....	.....	.....	.....	300°–350° C., 4.4 p. ct.
109	Do	.....	Tr	.....	9.0	.8680	91.0	.....	100	.....	.....	.....	.....	.....	.....	300°–350° C., 9.6 p. ct.
110	East End Field, Los Angeles City, Proudfitt & Parker.	.....	0	.....	17.9	.8871	82.1	.....	100	.....	.....	28.8	.....	.....	.....	Viscosity by Redwood viscometer over 1,800 at 15° C. 300° C. to asphalt, 51.1 p. ct. Gravities at 15° C.
111	East End Field, Los Angeles City, Davis & Harrison.	.....	0	.....	12.0	.8912	88.0	.....	100	0.49	.....	19.8	.....	.....	.....	Viscosity by Redwood viscometer over 1,800 at 15° C. 300° C. to asphalt, 36.3 p. ct. Gravities at 15° C. Calorific value per c. c. 9,863.
112	East End Field, Los Angeles City, Davis & Henderson.	.....	0	.....	24.1	.8776	75.9	.....	100	.....	.....	17.3	30.0	.....	.....	300° C. to asphalt, 57.6 p. ct. Gravities at 15°C. Viscosity by Redwood viscometer over 1,700 at 15° C.
113	East End Field, Los Angeles City, Consolidated Crude Oil Co.	.....	0	.....	12.3	.8835	87.7	.....	100	.....	.....	16.2	44.6	.....	.....	Gravities at 15° C. 300° C. to asphalt, 25.8 p. ct. Viscosity by Redwood viscometer over 1,800 at 15° C.
114	Knob Hill, Los Angeles City, Los Angeles Rwy. Co.	.....	0	.....	25.5	.8592	74.5	.....	100	.....	.....	21.5	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 51.6 p. ct. Viscosity by Redwood viscometer over 1,800 at 15° C.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Los Angeles County—Continued.								
115	Middle Field, Los Angeles City, J. W. Shirley		Well	12	1,340	0.9559	16.5		
116	Middle Field, Los Angeles City, Park Crude Oil Co.		do	13	1,060	.9706	14.2		
117	Middle Field, Los Angeles City, E. A. Clampitt		do	1	1,080	.9736	13.8		
118	West End Field, Los Angeles City, Salt Lake Oil Co.		do	4	1,264	.9487	17.6		
119	West End Field, Los Angeles City, Brea Rancho Oil and Asphalt Co.		do	14	410	1.010			
120	West End Field, Los Angeles City, Westlake Oil Co.			7	370	.9860	12.0		
121	Los Angeles					.9756	13.5		
122	Do					.9649	15.1	Greenish	
123	Do					.9609	15.7		
124	Newhall district, sec. 13, T. 3 N., R. 16 W		Tank			.9511	17.2		
125	Newhall district, sec. 4, T. 3 N., R. 15 W		Well			.8107	42.7		

115–120. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
121. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman.
122–125. California State Min. Bur. Bull. 31. Paul W. Prutzman.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.						
	CALIFORNIA—continued.														
	Los Angeles County—Con.														
115	Middle Field, Los Angeles City, J. W. Shirley.	.....	0	.....	21.5	0.8770	78.5	.....	100	0.85	.....	21.8	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 54.5 p. ct. Calorific value per c. c., 9,976. Viscosity by Redwood viscometer over 1,800 at 15° C.
116	Middle Field, Los Angeles City, Park Crude Oil Co.	.....	0	.....	26.3	.8852	73.7	.....	100	1.18	.....	25.3	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 44.2 p. ct. Calorific value per c. c., 10,073. Viscosity by Redwood viscometer over 1,800 at 15° C.
117	Middle Field, Los Angeles City, E. A. Clampitt.	.....	0	.....	20.0	.8805	80.0	.....	100	1.30	.....	28.8	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 47.2 p. ct. Calorific value per c. c., 9,377. Viscosity by Redwood viscometer over 1,800 at 15° C.
118	West End Field, Los Angeles City, Salt Lake Oil Co.	.....	10.8	0.7542	32.2	.8712	57.0	.....	100	.....	.....	26.8	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 29.7 p. ct., up to 100° C., 2.9 p. ct. Viscosity by Redwood viscometer 2,170 at 15° C.
119	West End Field, Los Angeles City, Brea Rancho Oil and Asphalt Co.	....	.....	.....	27.8	.8851	72.2	.....	100	.....	.....	42.2	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 20.9 p. ct. Viscosity by Redwood viscometer over 1,800 at 15° C.
120	West End Field, Los Angeles City, Westlake Oil Co.	.....	.....	.....	18.6	.9029	81.4	.....	100	.....	.....	21.3	35.7	.....	.....	Gravities at 15° C. 300° C. to asphalt, 22.4 p. ct. Viscosity by Redwood viscometer over 1,800 at 15° C.
121	Los Angeles.....	.....	.....	.....	10.0	.....	90.0	.....	100	1.082	.....	31.0	.....	.....	.....	150°–270° C.; above 270° C., 59 p. ct. Nitrogen 0.648 p. ct.
122	Do.....	.....	.....	.....	20.0	.8739	80.0	.....	100	.....	.....	13.3	.....	.....	.....	150°–270° C.; above 270° C., 63.7 p. ct.
123	Do.....	.....	.....	.....	17.2	.8739	82.8	.....	100	.....	.....	25.7	.....	.....	.....	150°–270° C.; above 270° C., 54.1 p. ct.
124	Newhall district, sec. 13, T. 3 N., R. 16 W.	.....	.....	.....	21.9	.8388	78.1	.....	100	.....	.....	25.9	.....	.....	.....	150°–270° C.; above 270° C., 50.2 p. ct.
125	Newhall district, sec. 4, T. 3 N., R. 15 W.	.....	51.0	.783	43.0	.8333	6.0	.....	100	.....	.....	.....	.....	.....	.....	150°–270° C.; above 270° C., 4 p. ct.; loss 2 p. ct.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Los Angeles County—Continued.								
126	Newhall district, Pearl Oil Co.		Well	3	662	0.9474	17.8		
127	Newhall district, Santa Ana Oil Co.		do	Santa No. 2	1,000	.9687	14.5		
128	Newhall district, Pacific Coast Oil Co.		do	2	1,000	.9666	14.8		
129	Newhall district, Santa Ana Oil Co.		do	2	1,000	.9879	11.7		
130	Newhall district, Pacific Coast Oil Co.		do	6	750	.8758	29.9		
131	Do.		do	4	1,400	.8969	26.1		
132	Newhall district.		do	Pico Canyon		.8440	35.9	Dark brown.	
133	Do.					.9068	43.1		
134	Do.					.8107	42.7		
135	Do.			Pico No. 2		.8650	31.9		

126. California State Min. Bur. Bull. 31. Paul W. Prutzman.
127–131. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
132–133. Soc. Chem. Indust. Jour., vol 6. Sir Boverton Redwood.
134. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman.
135. California State Min. Bur. Seventh Ann. Rept. W. D. Johnston, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.						
	CALIFORNIA—continued.														
	Los Angeles County—Contd.														
126	Newhall district, Pearl Oil Co.	.....	1.2	0.779	40.2	0.8723	58.6	.....	100	0.49	.....	22.7	.....	.....	.....	300° C. to asphalt, 34.8 p. ct. Gravities at 15° C. Calorific value per c. c., 9,911. Viscosity by Redwood viscometer 1,355 at 15° C.
127	Newhall district, Santa Ana Oil Co.	.....	.....	.....	23.7	.8767	76.3	.....	100	.72	.....	28.3	.....	3.5	.....	Gravities at 15° C. 300° C. to asphalt, 43.3 p. ct. Calorific value per c. c., 10,044. Viscosity by Redwood viscometer over 1,800 at 15° C.
128	Newhall district, Pacific Coast Oil Co.	.....	.....	.....	34.2	.8816	65.8	.....	100	.62	.....	22.6	.....	6.1	.....	Gravities at 15° C. 300° C. to asphalt, 34.6 p. ct. Calorific value per c. c., 10,042. Viscosity by Redwood viscometer over 1,800 at 15° C.
129	Newhall district, Santa Ana Oil Co.	.....	.....	.....	29.6	.8816	70.4	.....	100	.69	.....	22.6	.....	4.2	.....	Gravities at 15° C. 300° C. to asphalt 43 p. ct. Calorific value per c. c., 10,139. Viscosity by Redwood viscometer over 1,800 at 15° C.
130	Newhall district, Pacific Coast Oil Co.	.....	20.3	.7686	34.1	.8424	45.6	.....	100	.....	.....	10.9	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 30.3 p. ct. Viscosity by Redwood viscometer 61 at 15° C.
131	Do	.....	30.9	.7595	37.9	.8315	32.2	.....	101	.28	.....	6.8	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 23 p. ct. Calorific value per c. c., 9,322. Viscosity by Redwood viscometer 38.5 at 15° C.
132	Newhall district	.....	15.0	.....	45.0	.....	40.0	.....	100	.....	.....	.....	.....	.....	.....	Lubricating oil, 32 p. ct.
133	Do	.....	12.5	.....	78.47	.....	9.03	.....	100	.....	.....	5.3	.....	.....	.....	.....
134	Do	.....	51.0	.....	[a]43.0	.....	.....	.....	100	.....	.....	.....	.....	.....	.....	[a] 150°–270° C.; above 270° C., 6 p. ct.
135	Do	.....	10.6	.781	48.1	.8247	41.3	.....	100	.....	.....	.....	.....	.....	.....	150°–200° C., 20.6 p. ct.; sp. gr., 0.800. 200°–250° C., 16.2 p. ct.; sp. gr., 0.883. 250°–300° C., 11.30 p. ct.; sp. gr., 0.858.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties. Gravity at 60° F. Specific.	Gravity at 60° F. Baumé.	Color.	Odor.
	CALIFORNIA—continued.								
	Los Angeles County—Continued.								
136	Newhall district			Pico Canyon, H. & S., No. 3.		0.8460	35.5		
137	Do			Pico No. 4		.8250	39.7		
138	Do			Pico No. 9		.8360	37.5		
139	Do			Pico No. 13		.8320	38.3		
140	Do		Well	San Fernando		.8300	38.7		
141	Newhall district, Pacific Coast Oil Co.		do	Pico Canyon		.8414	36.4	Dark green	
142	Puente district								
143	Do		Tank	3, 4, 5, 6		.8220	40.3		

136–140. California State Min. Bur. Seventh Ann. Rept. W. D. Johnston, chemist.
141. Am. Chem. Jour., vol. 15, p. 19. Felix Lengfield and Edmond O'Neill.
142. U. S. Geol. Survey Mineral Resources, 1892, p. 650, 1893. Joseph D. Weeks.
143. California State Min. Bur. Seventh Ann. Rept. W. D. Johnston, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Begins to distill at (°C.)	Distillation by Engler's method. By volume. To 150° C. Cubic centimeters.	To 150° C. Specific gravity.	150°–300° C. Cubic centimeters.	150°–300° C. Specific gravity.	Residuum. Cubic centimeters.	Residuum. Specific gravity.	Total. Cubic centimeters.	Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent). Crude.	Unsaturated hydrocarbons (per cent). 150°–300° C.	Remarks.
	CALIFORNIA—continued.															
136	Los Angeles County—Con. Newhall district		30.0	0.7484	35.5	0.8593	34.5		100							
137	Do		29.8	.7943	35.0	.8135	35.0		100							
138	Do		30.0	.7948	33.0	.8326	37.0		100							
139	Do		31.5	.7953	33.0	.8151	35.5		100							
140	Do		31.7	.7956	36.7	.8592	31.6		100							
141	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
142	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
143	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
144	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
145	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
146	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
147	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
148	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
149	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
150	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
151	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
152	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
153	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
154	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
155	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
156	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
157	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
158	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
159	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
160	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
161	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
162	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
163	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
164	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
165	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
166	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
167	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
168	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
169	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
170	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
171	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
172	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
173	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
174	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
175	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
176	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
177	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
178	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
179	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
180	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
181	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
182	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
183	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
184	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
185	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
186	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
187	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
188	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
189	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
190	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
191	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
192	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
193	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
194	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
195	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
196	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
197	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
198	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
199	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
201	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
202	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
203	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
204	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
205	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
206	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
207	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
208	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
209	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
210	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
211	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
212	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
213	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
214	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
215	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
216	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
217	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
218	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
219	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
220	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
221	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
222	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
223	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
224	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
225	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
226	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
227	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
228	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
229	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
230	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
231	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
232	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
233	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
234	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
235	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
236	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
237	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
238	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
239	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
240	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
241	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
242	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
243	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
244	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
245	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
246	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
247	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
248	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
249	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
250	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
251	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
252	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
253	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
254	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
255	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
256	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
257	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
258	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
259	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
260	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
261	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
262	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
263	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
264	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
265	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
266	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
267	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
268	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
269	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
270	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
271	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
272	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
273	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
274	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
275	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
276	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
277	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
278	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
279	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
280	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
281	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
282	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
283	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
284	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
285	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
286	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
287	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
288	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
289	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
290	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
291	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Los Angeles County—Continued.								
144	Puente district, Puente Oil Co		Well	6	1,425	0.8775	29.5		
145	Puente district					.8893	27.4		
146	Do					.8929	26.8		
147	Do					.8929	26.8		
148	Do					.8799	29.1		
149	Do					.9193	22.3		
150	Do					.8861	28.0		
151	Sarelnesca Ranch, Union Oil Co		Well	5	1,500	.9656	15.0		
152	Whittier Field					.9396	19.0		
153	Whittier Field, Whittier-Fillmore Oil Co		Well	1	2,300	.9669	14.8		
154	Whittier Field, Home Oil Co., sec. 22, T. 2 S				1,713	.9291	20.7		
155	Whittier Field, Central Oil Co., sec. 22, T. 2 S				1,856	.9215	21.9		
156	Whittier Field, sec. 26, T. 2 S., R. 11 W		Well			.9309	20.4		

144-145. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
146-148. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
149-150. California State Min. Bur. Bull. 11. Laboratory analyses.
151. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
152. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman, analyst.
153. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
156. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.).	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	CALIFORNIA—continued.														
	Los Angeles County—Con.														
144	Puente district, Puente Oil Co.	.....	23.4	0.7564	33.1	0.8442	43.5	.....	100	0.36	.....	13.1	.....	.....	.....	Gravities at 15° C. 100°–150° C., 8 p. ct. 300° C. to asphalt, 28.8 p. ct. Calorific value per c. c., 9,389. Viscosity by Redwood viscometer 66.5 at 15° C.
145	Puente district	.....	10.2	.7323	35.91	.8019	53.89	.....	100	.....	.....	.....	.....	.....	.....	150°–200° C., 13.47 p. ct.; sp. gr., 0.7656. 200°–250° C., 12.24 p. ct.; 250°–300° C., 10.2 p. ct.; sp. gr., 0.8413.
146	Do	.....	10.5	.740	a28.0	.8065	61.5	.....	100	.....	.....	26.0	.....	.....	.....	a 150°–270° C.; above 270° C., 33 p. ct.
147	Do	.....	12.5	.7415	a29.0	.8121	58.5	.....	100	.....	.....	24.0	.....	.....	.....	a 150°–270° C.; above 270° C., 33 p. ct.
148	Do	.....	21.0	.7439	a24.0	.8168	55.0	.....	100	.....	.....	22.1	.....	.....	.....	a 150°–270° C.; above 270° C., 30.9 p. ct.
149	Do	.....	Tr.	.....	36.0	.7893	64.0	.....	100	.....	.....	.....	.....	.....	.....	300°–350° C., 2.9 p. ct.; sp. gr., 0.8610.
150	Do	.....	10.2	.7323	35.9	.8018	53.9	.....	100	.....	.....	.....	.....	.....	.....	300°–350° C., 8.5 p. ct.; sp. gr., 0.8502.
151	Sarcinesca Ranch, Union Oil Co.	.....	.....	.....	41.9	.8752	58.1	.....	100	.....	.....	28.4	.....	.....	.....	300° C., to asphalt, 28.5 p. ct.; sp. gr., 0.891. 150°–200° C., 5.2 p. ct.; sp. gr., 0.8197. 200°–250° C., 11.6 p. ct.; sp. gr., 0.8648. 250°–300° C., 25.1 p. ct.; sp. gr., 0.8915. Viscosity by Engler viscometer over 1,800 at 15° C.
152	Whittier field	.....	5.0	.....	a20.0	.....	75.0	.....	100	.70	.....	37.0	.....	.....	.....	a 150°–270° C.; above 270° C., 38 p. ct. Maumene No. 0.335. Nitrogen, 0.669.
153	Whittier Field, Whittier-Fillmore Oil Co.	.....	.....	.....	28.6	.8834	71.4	.....	100	.93	.....	26.5	.....	.....	.....	250°–300° C., 19.5 p. ct.; 300° C. to asphalt, 41.4 p. ct. Calorific value per c. c., 10,064. Gravities at 15° C. Viscosity by Redwood viscometer over 1,800 at 15° C.
154	Whittier Field, Home Oil Co., sec. 22, T. 2 S.	.....	4.2	.7756	38.3	.8704	57.5	.....	100	.....	.....	15.7	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 39.8 p. ct. Viscosity by Redwood viscometer 393 at 15° C.
155	Whittier Field, Central Oil Co., sec. 22, T. 2 S.	.....	6.9	.7760	32.7	.8543	60.4	.....	100	.....	.....	20.6	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 39.4 p. ct. Viscosity by Redwood viscometer 325 at 15° C.
156	Whittier Field, sec. 26, T. 2 S., R. 11 W.		0	.....	a23.4	.8328	76.6	.....	100	.....	.....	27.3	.....	.....	.....	a 150°–270° C.; above 270° C., 45.3 p. ct.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Los Angeles County—Continued.								
157	Whittier field, sec. 26, T. 2 S., R. 11 W		Well			0.9272	21.0		
158	Do		do			.9144	23.1		
159	Do		do			.9138	23.2		
	Marin County:								
160	Bolinas Bay		do			.9241	21.5		
161	Do					.9241	21.5		
162	Monterey County					.8929	26.8		
163	Do								
	Napa County:								
164	Berryessa Valley					.9642	15.2		
165	Do					.9642	15.2		
166	Do					.9677	14.7	Dark brown	
167	Do					.9625	15.5	Brown	
	Orange County:								
168	Fullerton, Columbia Oil Producing Co		Well		680	.9378	19.3		
169	Fullerton, sec. 8, T. 3 S		do	Santa Fe	2,404	.9399	19.0		
170	Fullerton, sec. 9, T. 3 S		do	Santa Fe 39	1,705	.8536	34.0		

157-160. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
161, 162. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman, analyst.
163. California State Min. Bur. Seventh Ann. Rept., 1887. W. D. Johnston, chemist.
164. California State Min. Bur. Bull. 19. Paul W. Prutzman, analyst.
165. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman, analyst.
166-167. Am. Chem. Soc. Jour., vol. 25, p. 669. Edmond O'Neill.
168-170. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.).	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.					Crude	150°–300° C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	CALIFORNIA—continued.															
	Los Angeles County—Con.															
157	Whittier field, sec. 26, T. 2 S., R. 11 W.	.....	2.1	0.7568	a23.9	0.8328	74.0	.....	100	.....	.....	21.4	.....	.....	.....	a 150°–270° C.; above 270° C., 48.4 p. ct.
158	Do	.....	5.2	.7568	a27.3	.8314	67.5	.....	100	.....	.....	20.2	.....	.....	.....	a 150°–270° C.; above 270° C., 44.7 p. ct.
159	Do	.....	4.7	.7475	a24.0	.8269	71.3	.....	100	.....	.....	19.7	.....	.....	.....	a 150°–270° C.; above 270° C., 46.9 p. ct.
	Marin County:															
160	Bolinas Bay	.....	4.0	.7543	a20.7	.8088	75.3	.....	100	.....	.....	22.9	.....	.....	.....	a 150°–270° C.; above 270° C., 50 p. ct.
161	Do	.....	2.0	.....	a24.0	.....	74.0	.....	100	.....	.....	22.0	.....	.....	.....	a 150°–270° C.; above 270° C., 52 p. ct. Maumene No. 0.370.
162	Monterey County	.....	0	.....	a 2.0	.....	98.0	.....	100	.....	.....	.....	.....	.....	.....	a 150°–270° C.; above 270° C., 98 p. ct.
163	Do	.....	0	.....	37.8	.868	62.2	.....	100	.....	.....	.....	.....	.....	.....	180°–200° C., 9.4 p. ct., sp. gr., 0.840; 200°–250° C., 18 p. ct., sp. gr., 0.867.
	Napa County:															
164	Berryessa Valley	.....	.....	.....	.....	.....	.....	.....	96.0	0.00	.....	3.66	.....	.....	.....	Temperature not given. Lubricating oil, 46 p. ct.; gas oil, 32 p. ct.; residuum, 18 p. ct.
165	Do	.....	0	.....	a15.0	.....	85.0	.....	100.0	.....	.....	.....	.....	.....	.....	a 150°–270° C.; above 270° C., 78 p. ct.; residuum, 7 p. ct. Maumene No. 0.153.
166	Do	.....	0	.....	a15.7	.....	84.3	.....	100.0	.....	.....	11.4	.....	.....	.....	a 250°–350° C.; 350° C. to asphalt 72.6 p. ct.
167	Do	.....	0	.....	a87.0	.....	13.0	.....	100.0	.....	.....	9.0	.....	.....	.....	a 250°–350° C.; 350° C. to asphalt, 4.2 p. ct.; hydrogen, 11.13 p. ct.; carbon, 88.08 p. ct. Viscosity 10.35 at 15.5° C. (Engler method).
	Orange County:															
168	Fullerton, Columbia Oil Producing Co.	.....	8.1	.7481	34.6	.8638	57.3	.....	100.0	.....	.....	25.8	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 31.2 p. ct. Viscosity by Redwood viscometer 1,020 at 15° C.
169	Fullerton, sec. 8, T. 3 S.	.....	0	.....	37.2	.8544	62.8	.....	100.0	1.09	.....	23.1	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 38.2 p. ct. Calorific value per c. c., 9,813. Viscosity by Redwood viscometer 1,790 at 15°C.
170	Fullerton, sec. 9, T. 3 S.	.....	28.2	.7459	32.2	.8381	39.6	.....	100.0	.41	.....	11.0	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 26 p. ct. Calorific value per c. c., 9,200. Viscosity by Redwood viscometer 45.5 at 15° C.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Orange County—Continued.								
171	Fullerton, Brea Canyon Oil Co.		Well	12	1,515	0.9147	23.1		
172	Fullerton, sec. 8, T. 3 S., R. 9 W.					.9596	15.9		
173	Do.		Tank			.9315	20.3		
174	Do.		Well			.9802	20.5		
175	Fullerton, sec. 1, T. 3 S., R. 10 W.		do			.9132	23.3		
176	Fullerton, sec. 9, T. 3 S., R. 9 W.		do			.8621	32.4		
177	Do.		do			.8600	32.8		
178	Do.		do			.8589	33.0		
179	Do.		do			.8568	33.4		
180	Do.		do			.8511	34.5		
181	Fullerton		do	Santa Fe		.9421	18.6	Brown	
	San Mateo County:								
182	(Not located)					.8163	41.5		
183	Do.					.7830	48.8		
184	Do.					.9206	22.1	Brown	

171. California State Min. Bur. Bull. 31. H. N. Cooper, Chemist.
172-180. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
181. Soc. Chem. Indust. Jour., No. 19. Clifford Richardson.
182-183. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman, analyst.
184. Am. Chem. Soc. Jour., vol. 25, p. 669. Edmond O'Neill.

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Analysis of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.									
	CALIFORNIA—continued.														
	Orange County—Continued.														
171	Fullerton, Brea Canyon Oil Co.	.....	18.1	0.7597	36.9	0.8663	45.5	.....	100.5	0.94	.....	13.3	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 29.2 p. ct. Calorific value per c. c., 9,678. Viscosity by Redwood viscometer 264 at 15° C
172	Fullerton, sec. 8, T. 3 S., R. 9 W.	.....	1.0	.....	[a]14.0	.8393	85.0	.....	100.0	.....	.....	42.0	.....	.....	.....	[a] 150°–270° C.; above 270° C., 41 p. ct.
173	Do	.....	Tr.	.....	[a]23.0	.8178	77.0	.....	100.0	.....	.....	32.1	.....	.....	.....	[a] 150°–270° C.; above 270° C., 42.9 p. ct.
174	Do	.....	3.4	.7535	[a]18.8	.8269	77.8	.....	100.0	.....	.....	25.9	.....	.....	.....	[a] 150°–270° C.; above 270° C., 47.6 p. ct.
175	Fullerton, sec. 1 T. 3 S., R. 10 W.	.....	10.5	.7487	[a]25.5	.8240	64.0	.....	100.0	.....	.....	31.6	.....	.....	.....	[a] 150°–270° C.; above 270° C., 31.4 p. ct.
176	Fullerton, sec. 9, T. 3 S., R. 9 W.	.....	21.7	.7403	[a]25.8	.8163	52.5	.....	100.0	.....	.....	9.0	.....	.....	.....	[a] 150°–270° C.; above 270° C., 41.8 p. ct.
177	Do	.....	23.8	.7384	[a]27.7	.8202	49.5	.....	101.0	.....	.....	16.7	.....	.....	.....	[a] 150°–270° C.; above 270° C., 31.2 p. ct.
178	Do	.....	24.8	.7334	[a]27.6	.8102	47.6	.....	100.0	.....	.....	15.6	.....	.....	.....	[a] 150°–270° C.; above 270° C., 31.4 p. ct.
179	Do	.....	22.1	.7334	[a]30.8	.8173	47.1	.....	100.0	.....	.....	8.0	.....	.....	.....	[a] 150°–270° C.; above 270° C., 37.6 p. ct.
180	Do	.....	22.9	.7288	[a]27.9	.8092	49.2	.....	100.0	.....	.....	12.9	.....	.....	.....	[a] 150°–270° C.; above 270° C., 33.4 p. ct.
181	Fullerton	35	2.4	.788	[a]8.2	.8319	89.4	.....	100.0	.....	.....	.....	.....	.....	.....	[a] 135°–175° C., color of distillate pink, refractive index 1.435. Distillation under 25 mm. pressure, as follows: 40°–100° C., 4.2 p. ct.; sp. gr. 0.8745, refractive index, 1.455; 100°–150° C., 10.4 p. ct.; sp. gr., 0.9195, refractive index, 1.478; 150°–165° C., 7 p. ct.; sp. gr., 0.9547; refractive index, 1.496. Begins to crack; residue, 66.4 p. ct.
	San Mateo County:														
182	(Not located)	.....	39.0	.....	[a]46.0	.....	15.0	.....	100.0	.....	.....	.....	.....	.....	.....	[a] 150°–270° C.; above 270° C., 15 p. ct.
183	Do	.....	48.0	.....	[a]33.0	.....	.....	.....	100.0	.....	.....	.....	.....	.....	.....	[a] 150°–270° C.; above 270° C., 19 p. ct.
184	Do	.....	.....	.....	.....	.....	100.0	.....	100.0	.....	.....	26.0	14.90	.....	.....	350° C. to asphalt, 58.9 p. ct. Viscosity, 10.96 at 15.5° C. (Engler method).

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Los Angeles County—Continued.								
126	Newhall district, Pearl Oil Co.		Well	3	662	0.9474	17.8		
127	Newhall district, Santa Ana Oil Co.		do	Santa No. 2	1,000	.9687	14.5		
128	Newhall district, Pacific Coast Oil Co.		do	2	1,000	.9666	14.8		
129	Newhall district, Santa Ana Oil Co.		do	2	1,000	.9879	11.7		
130	Newhall district, Pacific Coast Oil Co.		do	6	750	.8758	29.9		
131	Do		do	4	1,400	.8969	26.1		
132	Newhall district		do	Pico Canyon		.8440	35.9	Dark brown	
133	Do					.8088	43.1		
134	Do					.8107	42.7		
135	Do			Pico No. 2		.8650	31.9		

126. California State Min. Bur. Bull. 31. Paul W. Prutzman.
127–131. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
132–133. Soc. Chem. Indust. Jour., vol 6. Sir Boverton Redwood.
134. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman.
135. California State Min. Bur. Seventh Ann. Rept. W. D. Johnston, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume. To 150° C.		By volume. 150°–300° C.		By volume. Residuum.		By volume. Total.								
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	CALIFORNIA—continued.															
	Los Angeles County—Contd.															
126	Newhall district, Pearl Oil Co.	.....	1.2	0.779	40.2	0.8723	58.6	.....	100	0.49	.....	22.7	.....	.....	.....	300° C. to asphalt, 34.8 p. ct. Gravities at 15° C. Calorific value per c. c., 9,911. Viscosity by Redwood viscometer 1,355 at 15° C.
127	Newhall district, Santa Ana Oil Co.	.....	.....	.....	23.7	.8767	76.3	.....	100	.72	.....	28.3	.....	3.5	.....	Gravities at 15° C. 300° C. to asphalt, 43.3 p. ct. Calorific value per c. c., 10,044. Viscosity by Redwood viscometer over 1,800 at 15° C.
128	Newhall district, Pacific Coast Oil Co.	.....	.....	.....	34.2	.8816	65.8	.....	100	.62	.....	22.6	.....	6.1	.....	Gravities at 15° C. 300° C. to asphalt, 34.6 p. ct. Calorific value per c. c., 10,042. Viscosity by Redwood viscometer over 1,800 at 15° C.
129	Newhall district, Santa Ana Oil Co.	.....	.....	.....	29.6	.8816	70.4	.....	100	.69	.....	22.6	.....	4.2	.....	Gravities at 15° C. 300° C. to asphalt 43 p. ct. Calorific value per c. c., 10,139. Viscosity by Redwood viscometer over 1,800 at 15° C.
130	Newhall district, Pacific Coast Oil Co.	.....	20.3	.7686	34.1	.8424	45.6	.....	100	.....	.....	10.9	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 30.3 p. ct. Viscosity by Redwood viscometer 61 at 15° C.
131	Do	.....	30.9	.7595	37.9	.8315	32.2	.....	101	.28	.....	6.8	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 23 p. ct. Calorific value per c. c., 9,322. Viscosity by Redwood viscometer 38.5 at 15° C.
132	Newhall district	.....	15.0	.....	45.0	.....	40.0	.....	100	.....	.....	.....	.....	.....	.....	Lubricating oil, 32 p. ct.
133	Do	.....	12.5	.....	78.47	.....	9.03	.....	100	.....	.....	5.3	.....	.....	.....	.....
134	Do	.....	51.0	.....	a43.0	.....	.....	.....	100	.....	.....	.....	.....	.....	.....	a 150°–270° C.; above 270° C., 6 p. ct.
135	Do	.....	10.6	.781	48.1	.8247	41.3	.....	100	.....	.....	.....	.....	.....	.....	150°–200° C., 20.6 p. ct.; sp. gr., 0.800. 200°–250° C., 16.2 p. ct.; sp. gr., 0.833. 250°–300° C., 11.30 p. ct.; sp. gr., 0.858.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Los Angeles County—Continued.								
136	Newhall district			Pico Canyon, H. & S., No. 3.		0.8460	35.5		
137	Do			Pico No. 4		.8250	39.7		
138	Do			Pico No. 9		.8360	37.5		
139	Do			Pico No. 13		.8320	38.3		
140	Do		Well	San Fernando		.8300	38.7		
141	Newhall district, Pacific Coast Oil Co		do	Pico Canyon		.8414	36.4	Dark green	
142	Puente district								
143	Do		Tank	3, 4, 5, 6		.8220	40.3		

136–140. California State Min. Bur. Seventh Ann. Rept. W. D. Johnston, chemist.
141. Am. Chem. Jour., vol. 15, p. 19. Felix Lengfield and Edmond O'Neill.
142. U. S. Geol. Survey Mineral Resources, 1892, p. 650, 1893. Joseph D. Weeks.
143. California State Min. Bur. Seventh Ann. Rept. W. D. Johnston, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	CALIFORNIA—continued.															
	Los Angeles County—Con.															
136	Newhall district		30.0	0.7484	35.8	0.8333	34.2		100							Below 100° C., 11.20 p. ct.; sp. gr., 0.723. 100°–125° C., 9.30 p. ct.; sp. gr., 0.752. 125°–150° C., 9.5 p. ct.; sp. gr., 0.775. 150°–200° C., 13.60 p. ct.; sp. gr., 0.802.
137	Do		28.8	.7347	35.6	.8135	35.6		100							Below 100° C., 9.10 p. ct.; sp. gr., 0.702. 100°–125° C., 10.4 p. ct.; sp. gr., 0.739. 125°–150° C., 9.3 p. ct.; sp. gr., 0.762. 150°–200° C., 13.4 p. ct.; sp. gr., 0.787.
138	Do		29.6	.7355	33.2	.8205	37.2		100							Below 100° C., 13.1 p. ct.; sp. gr., 0.710. 100°–125° C., 6.5 p. ct.; sp. gr., 0.743. 125°–150° C., 10 p. ct.; sp. gr., 0.764. 150°–200° C., 13.6 p. ct.; sp. gr., 0.794.
139	Do		24.5	.7352	36.2	.8124	39.3		100							Below 100° C., 9.7 p. ct.; sp. gr., 0.713. 100°–125° C., 8.8 p. ct.; sp. gr., 0.742. 125°–150° C., 6 p. ct.; sp. gr., 0.761. 150°–200° C., 12 p. ct.; sp. gr., 0.783.
140	Do		37.7	.7436	30.7	.8259	31.6		100							Below 100° C., 17.3 p. ct.; sp. gr., 0.720. 100°–125° C., 11 p. ct.; sp. gr., 0.753. 125°–150° C., 9.4 p. ct.; sp. gr., 0.776. 150°–200° C., 13.3 p. ct.; sp. gr., 0.803.
141	Newhall district, Pacific Coast Oil Co.	Below 40														Refractive index 1.481 at 14° C.; 18 liters distilled; collected every 10°; per cent distillate not given.
142	Puente district		15.0		26.0		59.0		100			18.0				
143	Do		27.0	.7421	23.4	.8360	49.6		100							Below 100° C., 10.6 p. ct.; sp. gr., 0.717. 100°–125° C., 8.7 p. ct.; sp. gr., .747. 125°–150° C., 7.7 p. ct.; sp. gr., 0.771. 150°–200° C., 10.2 p. ct.; sp. gr., 0.803.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Los Angeles County—Continued.								
144	**Puente district, Puente Oil Co**		Well	6	1,425	0.8775	29.5		
145	**Puente district**					.8893	27.4		
146	**Do**					.8929	26.8		
147	**Do**					.8929	26.8		
148	**Do**					.8799	29.1		
149	Do					.9193	22.3		
150	Do					.8861	28.0		
151	Sarcinesca Ranch, Union Oil Co		Well	5	1,500	.9656	15.0		
152	Whittier Field					.9396	19.0		
153	Whittier Field, Whittier-Filmore Oil Co		Well	1	2,300	.9669	14.8		
154	Whittier Field, Home Oil Co., sec. 22, T. 2 S				1,713	.9291	20.7		
155	Whittier Field, Central Oil Co., sec. 22, T. 2 S				1,856	.9215	21.9		
156	**Whittier Field, sec. 26, T. 2 S., R. 11 W**		Well			.9309	20.4		

144–145. **California State Min. Bur. Bull. 31. H. N. Cooper, chemist.**
146–148. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
149–150. California State Min. Bur. Bull. 11. Laboratory analyses.
151. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
152. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. **Paul W. Prutzman, analyst.**
153. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
156. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.).	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.									
	CALIFORNIA—continued.														
	Los Angeles County—Con.														
144	Puente district, Puente Oil Co.	.....	23.4	0.7564	33.1	0.8442	43.5	.....	100	0.36	.....	13.1	.....	.....	.....	Gravities at 15° C. 100°–150° C., 8 p. ct. 300° C. to asphalt, 28.8 p. ct. Calorific value per c. c., 9,389. Viscosity by Redwood viscometer 66.5 at 15° C.
145	Puente district	.....	10.2	.7323	35.91	.8019	53.89	.....	100	.....	.....	.....	.....	.....	.....	150°–200° C., 13.47 p. ct.; sp. gr., 0.7656. 200°–250° C., 12.24 p. ct.; 250°–300° C., 10.2 p. ct.; sp. gr., 0.8413.
146	Do	.....	10.5	.740	a28.0	.8065	61.5	.....	100	.....	.....	26.0	.....	.....	.....	a 150°–270° C.; above 270° C., 33 p. ct.
147	Do	.....	12.5	.7415	a29.0	.8121	58.5	.....	100	.....	.....	24.0	.....	.....	.....	a 150°–270° C.; above 270° C., 33 p. ct.
148	Do	.....	21.0	.7439	a24.0	.8168	55.0	.....	100	.....	.....	22.1	.....	.....	.....	a 150°–270° C.; above 270° C., 30.9 p. ct.
149	Do	.....	Tr.	.....	36.0	.7893	64.0	.....	100	.....	.....	.....	.....	.....	.....	300°–350° C., 2.9 p. ct.; sp. gr., 0.8610.
150	Do	.....	10.2	.7323	35.9	.8018	53.9	.....	100	.....	.....	.....	.....	.....	.....	300°–350° C., 8.5 p. ct.; sp. gr., 0.8502.
151	Sarcinesca Ranch, Union Oil Co.	.....	.....	.....	41.9	.8752	58.1	.....	100	.....	.....	28.4	.....	.....	.....	300° C., to asphalt, 28.5 p. ct.; sp. gr., 0.891. 150°–200° C., 5.2 p. ct.; sp. gr., 0.8197. 200°–250° C., 11.6 p. ct.; sp. gr., 0.8648. 250°–300° C., 25.1 p. ct.; sp. gr., 0.8915. Viscosity by Engler viscometer over 1,800 at 15° C.
152	Whittier field	.....	5.0	.....	a20.0	.....	75.0	.....	100	.70	.....	37.0	.....	.....	.....	a 150°–270° C.; above 270° C., 38 p. ct. Maumene No. 0.335. Nitrogen, 0.669.
153	Whittier Field, Whittier-Fillmore Oil Co.	.....	.....	.....	28.6	.8834	71.4	.....	100	.93	.....	26.5	.....	.....	.....	250°–300° C., 19.5 p. ct.; 300° C. to asphalt, 41.4 p. ct. Calorific value per c. c., 10,064. Gravities at 15° C. Viscosity by Redwood viscometer over 1,800 at 15° C.
154	Whittier Field, Home Oil Co., sec. 22, T. 2 S.	.....	4.2	.7756	38.3	.8704	57.5	.....	100	.....	.....	15.7	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 39.8 p. ct. Viscosity by Redwood viscometer 393 at 15° C.
155	Whittier Field, Central Oil Co., sec. 22, T. 2 S.	.....	6.9	.7760	32.7	.8543	60.4	.....	100	.....	.....	20.6	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 39.4 p. ct. Viscosity by Redwood viscometer 325 at 15° C.
156	Whittier Field, sec. 26, T. 2 S., R. 11 W.		0	.....	a23.4	.8328	76.6	.....	100	.....	.....	27.3	.....	.....	.....	a 150°–270° C.; above 270° C., 45.3 p. ct.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Los Angeles County—Continued.								
157	Whittier field, sec. 26, T. 2 S., R. 11 W.		Well			0.9272	21.0		
158	Do.		do			.9144	23.1		
159	Do.		do			.9138	23.2		
	Marin County:								
160	Bolinas Bay		do			.9241	21.5		
161	Do.					.9241	21.5		
162	Monterey County					.8929	26.8		
163	Do.								
	Napa County:								
164	Berryessa Valley					.9642	15.2		
165	Do.					.9642	15.2		
166	Do.					.9677	14.7	Dark brown	
167	Do.					.9625	15.5	Brown	
	Orange County:								
168	Fullerton, Columbia Oil Producing Co.		Well		680	.9378	19.3		
169	Fullerton, sec. 8, T. 3 S.		do	Santa Fe	2,404	.9399	19.0		
170	Fullerton, sec. 9, T. 3 S.		do	Santa Fe 39	1,705	.8536	34.0		

157-160. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
161, 162. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman, analyst.
163. California State Min. Bur. Seventh Ann. Rept., 1887. W. D. Johnston, chemist.
164. California State Min. Bur. Bull. 19. Paul W. Prutzman, analyst.
165. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman, analyst.
166-167. Am. Chem. Soc. Jour., vol. 25, p. 669. Edmond O'Neill.
168-170. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.).	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300° C.	
	CALIFORNIA—continued.														
	Los Angeles County—Con.														
157	Whittier field, sec. 26, T. 2 S., R. 11 W.	.....	2.1	0.7568	a23.9	0.8328	74.0	.....	100	.....	.....	21.4	.....	.....	.....	a 150°–270° C.; above 270° C., 48.4 p. ct.
158	Do	.....	5.2	.7568	a27.3	.8314	67.5	.....	100	.....	.....	20.2	.....	.....	.....	a 150°–270° C.; above 270° C., 44.7 p. ct.
159	Do	.....	4.7	.7475	a24.0	.8269	71.3	.....	100	.....	.....	19.7	.....	.....	.....	a 150°–270° C.; above 270° C., 46.9 p. ct.
	Marin County:														
160	Bolinas Bay	.....	4.0	.7543	a20.7	.8088	75.3	.....	100	.....	.....	22.9	.....	.....	.....	a 150°–270° C.; above 270° C., 50 p. ct.
161	Do	.....	2.0	.....	a24.0	.....	74.0	.....	100	.....	.....	22.0	.....	.....	.....	a 150°–270° C.; above 270° C., 52 p. ct. Maumene No. 0.370.
162	Monterey County	.....	0	.....	a 2.0	.....	98.0	.....	100	.....	.....	.....	.....	.....	.....	a 150°–270° C.; above 270° C., 98 p. ct.
163	Do	.....	0	.....	37.8	.868	62.2	.....	100	.....	.....	.....	.....	.....	.....	180°–200° C., 9.4 p. ct., sp. gr., 0.840; 200°–250° C., 18 p. ct., sp. gr., 0.867.
	Napa County:														
164	Berryessa Valley	.....	.....	.....	.....	.....	.....	.....	96.0	0.00	.....	3.66	.....	.....	.....	Temperature not given. Lubricating oil, 46 p. ct.; gas oil, 32 p. ct.; residuum, 18 p. ct.
165	Do	.....	0	.....	a15.0	.....	85.0	.....	100.0	.....	.....	.....	.....	.....	.....	a 150°–270° C.; above 270° C., 78 p. ct.; residuum, 7 p. ct. Maumene No. 0.153.
166	Do	.....	0	.....	a15.7	.....	84.3	.....	100.0	.....	.....	11.4	.....	.....	.....	a 250°–350° C.; 350° C. to asphalt 72.6 p. ct.
167	Do	.....	0	.....	a87.0	.....	13.0	.....	100.0	.....	.....	9.0	.....	.....	.....	a 250°–350° C.; 350° C. to asphalt, 4.2 p. ct.; hydrogen, 11.13 p. ct.; carbon, 88.08 p. ct. Viscosity 10.35 at 15.5° C. (Engler method).
	Orange County:														
168	Fullerton, Columbia Oil Producing Co.	.....	8.1	.7481	34.6	.8638	57.3	.....	100.0	.....	.....	25.8	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 31.2 p. ct. Viscosity by Redwood viscometer 1,020 at 15° C.
169	Fullerton, sec. 8, T. 3 S.	.....	0	.....	37.2	.8544	62.8	.....	100.0	1.09	.....	23.1	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 38.2 p. ct. Calorific value per c. c., 9,813. Viscosity by Redwood viscometer 1,790 at 15°C.
170	Fullerton, sec. 9, T. 3 S.	.....	28.2	.7459	32.2	.8381	39.6	.....	100.0	.41	.....	11.0	.....	.....	.....	Gravities at 15°C. 300°C. to asphalt, 26 p. ct. Calorific value per c. c., 9,200. Viscosity by Redwood viscometer 45.5 at 15° C.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Orange County—Continued.								
171	Fullerton, Brea Canyon Oil Co.		Well	12	1,515	0.9147	23.1		
172	Fullerton, sec. 8, T. 3 S., R. 9 W.		Tank			.9596	15.9		
173	Do.		Well			.9315	20.3		
174	Do.		do			.9302	20.5		
175	Fullerton, sec. 1, T. 3 S., R. 10 W.		do			.9132	23.3		
176	Fullerton, sec. 9, T. 3 S., R. 9 W.		do			.8621	32.4		
177	Do.		do			.8600	32.8		
178	Do.		do			.8589	33.0		
179	Do.		do			.8568	33.4		
180	Do.		do			.8511	34.5		
181	Fullerton		do	Santa Fe		.9421	18.6	Brown	
	San Mateo County:								
182	(Not located)					.8163	41.5		
183	Do.					.7830	48.8		
184	Do.					.9206	22.1	Brown	

171. California State Min. Bur. Bull. 31. H. N. Cooper, Chemist.
172-180. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
181. Soc. Chem. Indust. Jour., No. 19. Clifford Richardson.
182-183. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman, analyst.
184. Am. Chem. Soc. Jour., vol. 25, p. 669. Edmond O'Neill.

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Analysis of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.									
	CALIFORNIA—continued.														
	Orange County—Continued.														
171	Fullerton, Brea Canyon Oil Co.	.....	18.1	0.7597	36.9	0.8663	45.5	.....	100.5	0.94	.....	13.3	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 29.2 p. ct. Calorific value per c. c., 9,678. Viscosity by Redwood viscometer 264 at 15° C
172	Fullerton, sec. 8, T. 3 S., R. 9 W.	.....	1.0	.....	[a]14.0	.8393	85.0	.....	100.0	.....	.....	42.0	.....	.....	.....	[a] 150°–270° C.; above 270° C., 41 p. ct.
173	Do	.....	Tr.	.....	[a]23.0	.8178	77.0	.....	100.0	.....	.....	32.1	.....	.....	.....	[a] 150°–270° C.; above 270° C., 42.9 p. ct.
174	Do	.....	3.4	.7535	[a]18.8	.8269	77.8	.....	100.0	.....	.....	25.9	.....	.....	.....	[a] 150°–270° C.; above 270° C., 47.6 p. ct.
175	Fullerton, sec. 1 T. 3 S., R. 10 W.	.....	10.5	.7487	[a]25.5	.8240	64.0	.....	100.0	.....	.....	31.6	.....	.....	.....	[a] 150°–270° C.; above 270° C., 31.4 p. ct.
176	Fullerton, sec. 9, T. 3 S., R. 9 W.	.....	21.7	.7403	[a]25.8	.8163	52.5	.....	100.0	.....	.....	9.0	.....	.....	.....	[a] 150°–270° C.; above 270° C., 41.8 p. ct.
177	Do	.....	23.8	.7384	[a]27.7	.8202	49.5	.....	101.0	.....	.....	16.7	.....	.....	.....	[a] 150°–270° C.; above 270° C., 31.2 p. ct.
178	Do	.....	24.8	.7334	[a]27.6	.8102	47.6	.....	100.0	.....	.....	15.6	.....	.....	.....	[a] 150°–270° C.; above 270° C., 31.4 p. ct.
179	Do	.....	22.1	.7334	[a]30.8	.8173	47.1	.....	100.0	.....	.....	8.0	.....	.....	.....	[a] 150°–270° C.; above 270° C., 37.6 p. ct.
180	Do	.....	22.9	.7288	[a]27.9	.8092	49.2	.....	100.0	.....	.....	12.9	.....	.....	.....	[a] 150°–270° C.; above 270° C., 33.4 p. ct.
181	Fullerton	35	2.4	.788	[a]8.2	.8319	89.4	.....	100.0	.....	.....	.....	.....	.....	.....	[a] 135°–175° C., color of distillate pink, refractive index 1.435. Distillation under 25 mm. pressure, as follows: 40°–100° C., 4.2 p. ct.; sp. gr. 0.8745, refractive index, 1.455; 100°–150° C., 10.4 p. ct.; sp. gr., 0.9195, refractive index, 1.478; 150°–165° C., 7 p. ct.; sp. gr., 0.9547; refractive index, 1.496. Begins to crack; residue, 66.4 p. ct.
	San Mateo County:														
182	(Not located)	.....	39.0	.....	[a]46.0	.....	15.0	.....	100.0	.....	.....	.....	.....	.....	.....	[a] 150°–270° C.; above 270° C., 15 p. ct.
183	Do	.....	48.0	.....	[a]33.0	.....	.....	.....	100.0	.....	.....	.....	.....	.....	.....	[a] 150°–270° C.; above 270° C., 19 p. ct.
184	Do	.....	.....	.....	.....	.....	100.0	.....	100.0	.....	.....	26.0	14.90	.....	.....	350° C. to asphalt, 58.9 p. ct. Viscosity, 10.96 at 15.5° C. (Engler method).

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	San Mateo County—Continued.								
185	Half Moon Bay					0.8154	41.7	Greenish	
186	Do					.7830	48.8		
187	Purissima Canyon		Well	Lane		.8550	33.7		
188	Do		do	Tunitas		.7990	45.2		
	San Benito County:								
189	Bitterwater district, sec. 32, T. 18 S., R. 10 E		do			.8107	42.7	Green	
190	Bitterwater district, Nonpareil Petroleum Co		do			.8107	42.7	do	
191	Bitterwater district					.8107	42.7		
192	Santa Cruz County					.9587	16.0	Black	
	Santa Clara County:								
193	(Not located)					.8537	34.0	Light Brown	
194	Sargent, Watsonville Oil Co		Well	2	1,187	.9416	18.7		

185. California State Min. Bur. Bull. 31.
186. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
187-188. California State Min. Bur. Seventh Ann. Rept. W. D. Johnston, chemist.
189. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
190. California State Min. Bur. Bull. 31. Name of analyst not given.
191. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman.
192-193. Am. Chem. Soc. Jour., vol. 25. Edmond O'Neill.
194. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.								
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	CALIFORNIA—continued.														
	San Mateo County—Contd.														
185	Half Moon Bay	.....	47.0	0.7414	34.7	0.8254	18.3	.....	100.0	.....	.....	.....	.....	.....	.....	Gasoline, 8.6 p. ct.; benzine, 12.9 p. ct.; engine distillate, 25.5 p. ct.; kerosene, 23.6 p. ct.; stove oil, 11.1 p. ct.; lubricants, 8 p. ct.
186	Do	.....	47.5	.728	a33.0	.800	19.5	.....	100.0	.....	.....	.....	.....	.....	.....	a 150°–270° C.; above 270° C., 16 p. ct.
187	Purissima Canyon	.....	18.0	.759	44.0	.817	38.0	.....	100.0	.....	.....	.....	.....	.....	.....	
188	Do	.....	46.7	.7414	35.0	.820	18.3	.....	100.0	.....	.....	.....	.....	.....	.....	Below 100° C., 9.9 p. ct.; 100°–125° C., 17.3 p. ct.; 125°–150° C., 19.5 p. ct.; 150°–200° C., 17.2 p. ct.; 200°–250° C., 11.8 p. ct.; 250°–300° C., 6 p. ct.
	San Benito County:															
189	Bitterwater district, sec. 32, T. 18 S., R. 10 E.	.....	31.0	.7341	a37.6	.814	31.4	.....	100.0	.....	.....	.....	.....	.....	.....	a 150°–270° C.; above 270° C., 25.7 p. ct.; sp. gr. 0.8772; residue, 4.3 p. ct.; not asphalt, though it contains that substance.
190	Bitterwater district, Nonpareil Petroleum Co.	.....	30.0	.....	50.0	.....	20.0	.....	100.0	.....	.....	.....	.....	.....	.....	Gasoline, 10 p. ct.; sp. gr., 0.7071; engine distillate, 20 p. ct.; sp. gr., 0.7547; kerosene, 35 p. ct.; sp. gr., 0.8046; stove oil, 15 p. ct., sp. gr. 0.8485; lubricants, 19.7 p. ct.; sp. gr. 0.9352.
191	Bitterwater district	.....	28.0	.....	a37.0	.....	35.0	.....	100.0	.....	.....	.....	.....	.....	.....	a 150–270° C.; above 270° C., 35 p. ct. Maumene No. 0.068.
192	Santa Cruz County	.....	0	.....	a6.2	.....	93.8	.....	100.0	.....	.....	22.8	21.5	.....	.....	a 150°–250° C.; 250°–350° C., 34 p. ct.; 350° C. to asphalt, 14.4 p. ct.
	Santa Clara County:															
193	(Not located)	.....	15.0	.....	a35.8	.....	49.2	.....	100.0	0.92	.....	3.6	.....	.....	.....	a 150°–250° C.; 250°–350° C., 31.2 p. ct.; 350° C. to asphalt, 14.4 p. ct. B. t. u. 20,145.6. Hydrogen, 12.88 p. ct., carbon, 86.08 p. ct.
194	Sargent, Watsonville Oil Co.	.....	9.0	.7656	41.4	.8848	49.6	.....	100.0	.83	.....	19.6	.....	.....	.....	Gravities at 15° C. Up to 100° C., 2 p. ct.; 100°–150° C., 7 p. ct.; 300° C. to asphalt, 27.2 p. ct. Calorific value per c. c., 9,786. Viscosity by Redwood viscometer, 750 at 15° C.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Santa Clara County—Continued.								
195	Sargent		Tank			0.9569	16.3		
196	Do		do			.9511	17.2		
197	Do		Well			.9421	18.6		
198	Moodys Gulch, Golden Gate Petroleum Co		do			.8333	38.0		
199	Moodys Gulch		do	4		.8120	42.4		
200	Do					.8333	38.0		
	Santa Barbara County:								
201	Lompoc, Union Oil Co		Well	Hill No. 1	2,500	.9574	16.2		
202	Summerland, Sea Cliff Oil Co		do			.9665	14.9		
203	Summerland, Potomac Oil Co		do	4	260	.9603	15.8		
204	Summerland		Tank			.9655	15.0		
205	Do		do			.9722	14.0		
206	Do					.9858	12.0	Black	

195–198. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
199. California State Min. Bur. Seventh Ann. Rept. W. D. Johnston, chemist.
200. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman.
201–203. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
204. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
205. California State Min. Bur. Bull. 31. Analyst not given.
206. Am. Chem. Soc. Jour., vol. 25, p. 669. Edmond O'Neill.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.					Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	CALIFORNIA—continued.															
	Santa Clara County—Contd.															
195	Sargent	.....	.8	.....	a20.0	0.8383	79.2	.....	100.0	.....	.....	24.2	.....	.....	.....	a 150°–270° C.; above 270° C., 50 p. ct.
196	Do	.....	1.0	.....	a18.0	.8419	81.0	.....	100.0	.....	.....	27.0	.....	.....	.....	a 150°–270° C.; above 270° C., 52 p. ct.
197	Do	.....	6.0	0.7568	a19.5	.8434	74.5	.....	100.0	.....	.....	37.0	.....	.....	.....	a 150°–270° C.; above 270° C., 35.5 p. ct.
198	Moodys Gulch, Golden Gate Petroleum Co.	.....	25.0	.7527	38.1	.8046	36.9	.....	100.0	.....	.....	.....	.....	.....	.....	No temperature given. Engine distillate, 25 p. ct.; sp. gr., 0.7527; gas oil, 33.9 p. ct.; sp. gr., 0.8642; paraffin, 0.3 p. ct.
199	Moodys Gulch	.....	33.8	.7449	35.5	.8201	30.7	.....	100.0	.....	.....	.....	.....	.....	.....	Below 100° C., 9.4 p. ct.; 100°–150° C., 24.4 p. ct.; sp. gr., 0.756; 150°–200° C., 17.1 p. ct.; sp. gr., 0.798; 200°–250° C., 14.8 p. ct.; sp. gr., 0.836.
200	Do	.....	26.0	.....	a35.0	.....	39.0	.....	100.0	.....	.....	0	.....	.....	.....	**a 150°–270° C.; above 270° C., 39 p. ct.**
	Santa Barbara County:															
201	Lompoc, Union Oil Co	.....	5.2	.....	31.5	.8417	63.3	.....	100.0	4.43	.....	20.6	7.0	.....	.....	Gravities at 15° C. Viscosity by Redwood viscometer over 1,800 at 15° C. 300° C. to asphalt, 34.3 p. ct. Calorific value per c. c., 9,822.
202	Summerland, Sea Cliff Oil Co.	.....	0	.....	28.4	.....	71.6	.....	100.0	.44	.....	23.5	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 45.5 p ct. Calorific value per c. c., 10,001. Viscosity by Redwood viscometer over 1,800 at 15° C.
203	Summerland, Potomac Oil Co.	.....	0	.....	28.3	.8693	71.7	.....	100.0	.....	.....	22.8	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 48 p. ct. Viscosity by Redwood viscometer over 1,800 at 15° C.
204	Summerland	.....	0	.....	a10.0	.8464	90.0	.....	100.0	.....	.....	32.2	.....	.....	.....	a 150°–270° C.; above 270° C., 54 p. ct.
205	Do	.....	.1	.....	7.0	.8187	92.9	.....	100.0	.....	.....	37.1	.....	.....	.....	Temperature not given. Gas oil, 16.3 p. ct., sp. gr. 0.8861; stove oil, 4 p. ct.; sp. gr., 0.8589.
206	Do	.....	0	.....	a 6.5	.....	93.5	.....	100.0	.....	.....	22.5	25.0	.....	.....	a 150°–250° C.; 250°–530° C., 17.10 p. ct.; 350° C. to asphalt, 27.5 p. ct. Viscosity 1,462 at 15.5° C. (Engler method.)

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Santa Barbara County—Continued.								
207	Summerland								
208	Do		Submarine well			0.9521	17.0		
209	Do					.9655	15.0		
210	Do					.9672	14.8		
211	Do					.9513	17.2		
212	Do					.9657	15.0		
213	Do					.9672	14.8		
214	Do					.9692	14.5		
215	Carreaga field					.9530	16.9	Black	

207. Pet. Rev., Dec. 8, 1906. Clifford Richardson.
208. Am. Acad. Arts and Sci., vol. 40, p. 340. C. F. Mabery and E. V. Zoni; also Franklin Inst. Jour., vol. 162, Jan., 1906.
209. U. S. Geol. Survey Mineral Resources, 1903, p. 177. 1904. Paul W. Prutzman.
210–214. California State Min. Bur. Bull. 11. Laboratory analyses.
215. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	CALIFORNIA—continued.															
	Santa Barbara County—Con.															
207	Summerland											45.0				Distilled in vacuo of 26 mm. pressure gave 55 p. ct. of distillate, collected in 15 portions; sp. gr. of fractions as follows: 0.8712, 0.8833, 0.8893, 0.9034, 0.9155, 0.9336, 0.9417, 0.9477, 0.9618, 0.9678, 0.9738, 0.9802, 0.9830, 0.990, 0.9939.
208	Do									0.84						Nitrogen, 1.25 p. ct.; carbon, 86.32 p. ct.; hydrogen, 11.7 p. ct. Distilled under pressure of 60 mm. Only small quantities passed over below 175° C.; residue of 10 p. ct. remained at 356° C. Following hydrocarbons isolated: At 20° C., $C_{13}H_{24}$; 150°–155° C., sp. gr. 0.8621, $C_{16}H_{30}$; 175°–180° C., sp. gr. 0.8808, $C_{17}H_{30}$; 190°–195° C., sp. gr. 0.8919, $C_{18}H_{32}$; 210°–215° C., sp. gr. 0.8996, $C_{24}H_{46}$; 250°–255° C., sp. gr. 0.9299, $C_{27}H_{46}$; 310°–315° C., sp. gr. 0.9451, $C_{29}H_{50}$; 340°–345° C., sp. gr. 0.9778.
209	Do		0		a11.0		89.0		100.0	.898		40.0				a 150°–270° C.; above 270° C. 49 p. ct. Nitrogen, 0.88.
210	Do		0		11.0	0.8452	89.0		100.0							300°–350° C., 5 p. ct., sp. gr. 0.8722.
211	Do		Tr.		21.4		78.6		100.0							300°–350° C., 12 p. ct., sp. gr. 0.8902.
212	Do		Tr.		11.6	.8468	88.4		100.0							300°–350° C., 6.8 p. ct., sp. gr. 0.8900.
213	Do		Tr.		6.0		94.0		100.0							300°–350° C., 5 p. ct.
214	Do		Tr.		Tr.		100.0		100.0							300°–350° C., 4.6 p. ct.
215	Carreaga Field		1.0		a24.0		75.0		100.0			38.0				a 150°–270° C.; above 270° C., 38 p. ct. Maumene No. 4.82. Nitrogen, 0.43. Viscosity by Redwood viscometer 790 at 15° C.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Santa Barbara County—Continued.								
216	Carreaga Field, Western Union Oil Co		Well			0.9303	20.5		
217	Do		do		2,776	.8508	34.6		
218	Near Casmalia Field, Western Union Oil Co		do	3	1,610	.9337	19.9		
219	Santa Maria Field, Pinal Oil Co		do	1,3	1,600	.8882	27.6		
220	Santa Maria Field					.9530	16.9		
221	Santa Maria Field, Pinal Oil Co								
222	(Not located)					.9804	12.8	Dark, almost black	

216–219. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
220. From 1905 statistical card giving production of well owner.
221–222. Am. Jour. Sci., 2d ser., vol. 43, p. 242. B. Silliman.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	CALIFORNIA—continued.															
	Santa Barbara County—Con.															
216	Carreaga Field, Western Union Oil Co.	.....	12.0	0.7481	43.2	0.8677	44.8	.....	100.0	.....	.....	17.9	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 27.4 p. ct.; 150°–200° C., 10.4 p. ct.; 200°–250° C., 8.3 p. ct.
217	Do	.....	24.6	.7508	36.2	.8312	39.2	.....	100.0	0.60	.....	8.0	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 30.4 p. ct. Calorific value per c. c., 9,203. Viscosity by Redwood viscometer 47.4 at 15° C.
218	Near Casmalia Field, Western Union Oil Co.	.....	6.9	.7596	30.8	.8508	62.3	.....	100.0	2.08	.....	22.0	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 39.5 p. ct. Calorific value per c. c., 9,907. Viscosity by Redwood viscometer 1,060 at 15° C.
219	Santa Maria Field, Pinal Oil Co.	.....	25.9	.7460	30.6	.8469	43.5	.....	100.0	1.56	.....	12.0	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 29.7 p. ct. Calorific value per c. c., 9,364. Viscosity by Redwood viscometer 90 at 15° C.
220	Santa Maria Field	.....	1.0	.....	a24.0	.8260	75.0	.....	100.0	.....	.....	41.9	.....	.....	.....	a 150°–270° C.; above 270° C., 31.1 p. ct.
221	Santa Maria Field, Pinal Oil Co.		12.0	.....	12.0	.....	76.0	.....	100.0	.....	.....	16.0	.....	.....	.....	No temperature given. Gas oil, 10 p. ct.; lubricating oil, 50 p. ct.
222	(Not located)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Distillation to dryness produced 69.82 p. ct., sp. gr. 0.890 to 0.900; coke, water, and loss 30.18 p. ct. Oil of 0.885 sp. gr., 50 p. ct.; oil of 0.908 sp. gr., 17.5 p. ct. First distillate treated by cracking yielded a product having a density of about 0.885 at 60° F., or only 1° Baumé lower than before distillation. After treatment with sulphuric acid and soda and redistilling from soda it had a density of 0.880.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Santa Barbara County—Continued.								
223	Hayward Petroleum Co		Tunnel			0.9023	25.2		
224	(Not located)		Pico Spring			.8932	26.7		
225	(Not located) Canada Loga					.9184	22.4		
226	(Not located)		Spring			.9780	13.2		
227	Ojai Valley					.9175	22.6		

223–226. Am. Jour. Sci., 2d ser., vol. 47, p. 10. S. F. Peckham.
227. Pet. Rev., Dec. 27, 1906. Clifford Richardson.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.					Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	CALIFORNIA—continued.															
	Santa Barbara County—Con.															
223	Hayward Petroleum Co.	.....	.....	.....	15.0	0.810	85.0	.....	100.0	.....	.....	.....	.....	.....	.....	40 to 50 p. ct. of middlings and 20 p. ct. light lubricating oil. Under pressure distillation 42 p. ct., sp. gr. 0.810; second pressure distillation of residue (49 p. ct.) yielded 44.15 p. ct.; second fractionation of sp. gr. 0.810, 12.25 p. ct. Total crude illuminating oil, 54.25 p. ct; lubricating oil, 31.85 p. ct.
224	(Not located)	.....	.....	.....	20.0	.....	80.0	.....	100.0	.....	.....	.....	.....	.....	.....	Under pressure distillation yielded 56.72 p. ct., sp. gr. 0.810; second pressure distillation of residue (30.94 p. ct.) yielded 28.74 p. ct.; second fractionation of sp. gr. 0.810, 6.96 p. ct. Total crude illuminating oil, 62.68 p. ct.; lubricating oil 20.88 p. ct.
225	(Not located) Canada Loga.	.....	.....	.....	3.0	.....	97.0	.....	100.0	.....	.....	.....	.....	.....	.....	Under pressure distillation yielded 40.33 p. ct., sp. gr. 0.810; second pressure distillation of residue (42.33 p. ct.) yielded 38.09 p. ct.; second fractionation of sp. gr. 0.810, 9.52 p. ct. Total crude illuminating oil, 49.85 p. ct.; lubricating oil, 25.87 p. ct.
226	(Not located)	.....	.....	.....	2.5	.....	97.5	.....	100.0	.....	.....	.....	.....	.....	.....	Sample from same spring as No. 222. Under pressure distillation yielded 16.7 p. ct., sp. gr. 0.810; second pressure distillation of residue (55.3 p. ct., water 12.5 p. ct.) yielded 49.8 p. ct.; second fractionation of sp. gr. 0.810, 12.4 p. ct. Total crude illuminating oil, 29.1 p. ct.; lubricating oil, 37.1 p. ct.
227	Ojai Valley	.....	23.4	0.7914	a31.8	.....	43.8	.....	99.0	.....	.....	.....	.....	.....	.....	a 150°–274° C.; 30°–80° C., 7.8 p. ct., sp. gr. 0.768; 80°–118° C., 7.6 p. ct., sp. gr. 0.7728; 118°–150° C., 7.8 p. ct., sp. gr. 0.8334.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
228	Ventura County					0.9120	23.5		
229	Do					.8997	25.6		
230	Do		Mixed crude			.9091	24.0		
231	Do		Pipe line			.8974	26.0		
232	Do		do			.9021	25.2		
233	Do					.9330	12.4		
234	Do					.9159	22.9	Brown	
235	Do					.9165	22.8	do	
236	Do					.8918	27.0	Brown, thick	

228. U. S. Geol. Survey Mineral Resources, 1896, 1897; from California State Min. Bur. Bull. 11. Frederick Salathe, analyst.
229. U. S. Geol. Survey Mineral Resources, 1903, p. 177, 1904. Paul W. Prutzman.
230. California State Min. Bur. Bull. 1, p. 78. M. L. Watts.
231–232. California State Min. Bur. Bull. 31, p. 193.
233–235. Am. Chem. Soc. Jour., vol. 25, p. 669. Edmond O'Neill.
236. Am. Chem. Jour., vol. 19, p. 797. Chas. F. Mabery.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.								
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300° C.	
	CALIFORNIA—continued.														
228	Ventura County									0.40						Carbon, 84 p. ct.; hydrogen, 12.7 p. ct.; nitrogen, 1.7 p. ct.; oxygen, 1.2 p. ct.
229	Do		10.0		[a]24.0		66.0		100.0	1.5		22.0				[a] 150°–270° C.; above 270° C. 44 p. ct.; nitrogen, 0.606.
230	Do		7.0		23.0		70.0		100.0			11.0				Average yield from 100 barrels determined by running: Gasoline, sp. gr. 0.6796, 3 barrels; benzine, sp. gr. 0.7254, 4 barrels; kerosene, sp. gr. 0.800, 15 barrels; kerosene, sp. gr. 38°–40° B., 8 barrels; gas distillate, sp. gr. 0.8861, 21 barrels; spindle oil, sp. gr. 0.8974, 10 barrels; neutral oil, sp. gr. 0.915, 12 barrels; heavy neutral oil, sp. gr. 0.9272, 6 barrels; lubricating oil, sp. gr. 0.9722, 5 barrels.
231	Do		10.4	0.7254	28.0	0.8116	61.6		100.0			23.7				Gas oil, 16.1 p. ct., sp. gr. 0.8861; lubricating oil, 20.3, p. ct. sp. gr. 0.915.
232	Do		14.5	.7568	13.8	.8140	71.7		100.0			14.9				Stove oil, 14.4 p. ct., sp. gr. 0.8589; fuel distillate, 22.8 p. ct., sp. gr. 0.8974; lubricant, 16 p. ct., sp. gr. 0.9272.
233	Do		0		[a]11.2		88.8		100.0			36.5	9.5			[a] 150°–250° C.; 250°–350° C., 34.05 p. ct.; 350° C. to asphalt, 8.75 p. ct.
234	Do		12.0		[a]16.0		72.0		100.0			13.8				[a] 150°–250° C.; 250°–350° C., 54.5 p. ct.; 350° C. to asphalt, 2.2 p. ct.
235	Do		17.0		[a]11.5		71.5		100.0			41.0				[a] 150°–250° C.; 250°–350° C., 9 p. ct.; 350° C. to asphalt, 21.5 p. ct.
236	Do	60	9.7	.7395	29.1		61.2		100.0	.84						Gravities at 20° C. Bromine absorption, 17.72. Percentage of nitrogen compound, 0.53 p. ct.; carbon, 85.60 p. ct.; hydrogen, 12.84 p. ct. Residue above 300° C. thick, nearly solid tar. (Vacuum distillation also given.)

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Ventura County—Continued.								
237	Adams Canyon		Well	Green		0.8530	34.1		
238	Do		do	Wild Bill		.9150	23.0		
239	Do					.9091	24.0	Greenish	
240	Adams Canyon; Union Oil Co		Well	27	2,745	.8814	28.8		
241	Do		Green Oil tunnel			.9326	20.1		
242	Buckhorn district; Buckhorn Oil and Trans. Co		Well	15	950	.9685	14.6		
243	Bardsdale Canyon; Union Oil Co		do	Robinson No. 2		.8881	27.7		
244	Bardsdale Canyon; sec. 12, T. 3 N., R. 20 W					.8861	28.0		
245	Bardsdale Canyon					.8905	27.2	Deep brown-black.	

237–238. California State Min. Bur. Seventh Ann. Rept., 1887. W. D. Johnston, chemist.
239. U. S. Geol. Survey Mineral Resources, 1896, p. 844, 1897; from California State Min. Bur. Bull. 1.
240–243. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
244. California State Min. Bur. Bull. 31. Paul W. Prutzman, chemist.
245. Pet. Rev., Dec. 27, 1906. Clifford Richardson.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	CALIFORNIA—continued.														
	Ventura County—Contd.														
237	Adams Canyon	.....	16.8	0.7518	42.4	0.8231	40.8	.....	100.0	.....	.....	.....	.....	.....	.....	100°–125° C., 7.8 p. ct.; 150°–200° C., 18 p. ct.; 200°–250° C., 14.4 p. ct.
238	Do	.....	9.2	.732	26.5	.8424	64.3	.....	100.0	.....	.....	.....	.....	.....	.....	150°–200° C., 10.8 p. ct., sp. gr. 0.813; 200°–250° C., 8 p. ct., sp. gr. 0.846.
239	Do	.....	5.2	.....	24.5	.....	70.3	.....	100.0	.....	.....	7.0	.....	.....	.....	Temperature not given. Gas distillate, 17.3 p. ct.; lubricating oil, 46 p. ct. Pyridine base equals 0.88 p. ct.
240	Adams Canyon; Union Oil Co.	.....	18.1	.7717	28.5	.8356	53.4	.....	100.0	0.48	.....	9.8	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 43 p. ct. Calorific value per c. c., 9,384. Viscosity by Redwood viscometer 162.5 at 15° C.
241	Do	.....	.8	.....	41.5	.8461	57.7	.....	100.0	.32	.....	16.6	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 40 p. ct. Calorific value per c. c., 9,889. Viscosity by Redwood viscometer 247 at 15° C.
242	Buckhorn district; Buckhorn Oil and Trans. Co.	.....	0	.....	27.2	.....	72.8	.....	100.0	.....	.....	23.0	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 40.4 p. ct. Water, 9.3 p. ct. Viscosity by Redwood viscometer over 1,800 at 15° C.
243	Bardsdale Canyon; Union Oil Co.	.....	19.5	.735	31.5	.839	49.0	.....	100.0	1.74	.....	16.9	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 29 p. ct. Calorific value per c. c., 9,310. Viscosity by Redwood viscometer 205 at 15° C.
244	Bardsdale Canyon; sec. 12, T. 3 N., R. 20 W.	.....	13.0	.7307	[a]20.5	.8074	66.5	.....	100.0	.....	.....	25.6	.....	.....	.....	[a] 150°–270° C.; above 270° C., 40 p. ct.
245	Bardsdale Canyon	.....	[a]22.0	.7406	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Gravities at 20° C. [a] 62°–154° C. 62°–120° C., 10 p. ct., refractive index 1.414. Under 26 mm. pressure, 48°–116° C., 13 p. ct., sp. gr. 0.7972, refractive index 1.443; 116°–152° C., 12 p. ct., sp. gr. 0.842; 152°–198° C., 11 p. ct., sp. gr. 0.8724; 198°–255° C., 10 p. ct., sp. gr. 0.9035 at 25° C.; 255°–310° C., 6 p. ct., sp. gr. 0.9216 at 45° C.; residue, 25.4 p. ct.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Ventura County—Continued.								
246	Sespe district					0.9402	18.9		
247	Four Forks					.9196	22.2		
248	Do					.8687	31.2	Reddish brown	
249	Do					.9091	24.0		
250	Do					.9021	25.2		

246, 247. California State Min. Bur. Bull. 1. Analyst not given.
248. Pet. Rev., Jan. 5, 1907. Clifford Richardson.
249, 250. U. S. Geol. Survey Mineral Resources, 1896, p. 845, 1897. Frederick Salathe, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°-300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°-300° C.	
	CALIFORNIA—continued.														
	Ventura County—Contd.														
246	Sespe district	.....	.....	.....	28.21	0.8081	71.79	.....	100.0	.....	.....	.....	.....	.....	.....	300°-350° C., 2.95 p. ct. by volume, 2.7 p. ct. by weight, sp. gr. 0.8608; 200° C., 7.27 p. ct. by volume, 6 p. ct. by weight, sp. gr. 0.7649; 250° C., 9.47 p. ct. by volume, 8.07 p. ct. by weight, sp. gr. 0.8012.
247	Four Forks	.....	.....	.....	33.47	.8051	66.53	.....	100.0	.....	.....	.....	.....	.....	.....	300°-350° C., 6.63 p. ct. by volume, 6.21 p. ct. by weight, sp. gr. 0.8604; 200° C., 6.94 p. ct. by volume, 5.80 p. ct. by weight, sp. gr. 0.7684; 250° C., 16.84 p. ct. by volume, 14.64 p. ct. by weight, sp. gr. 0.8005.
248	Do	48	20.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[a] 48°-148° C.; 48°-115° C., 10 p. ct., sp. gr. 0.7483, refractive index 1.418; 115°-148° C., 10 p. ct., sp. gr. 0.7066, refractive index 1.412. Under 26 mm. pressure, 56°-96° C., 10 p. ct., sp. gr. 0.7855, refractive index 1.437; 96°-138° C., 10 p. ct., sp. gr. 0.820, refractive index 1.454; 138°-173° C., 10 p. ct., sp. gr. 0.847, refractive index 1.469; 173°-219° C., 10 p. ct., sp. gr. 0.837, refractive index 1.484; 219°-265° C., 10 p. ct., sp. gr. 0.9026, refractive index 1.502; 265°-284° C., 10 p. ct., sp. gr. 0.9214, refractive index 1.513. Residue 21.2 p. ct.
249	Do	.....	6.0	.....	17.1	.....	76.9	.....	100.0	.....	.....	.....	.....	.....	.....	Gas distillates, 29.5 p. ct., lubricating, 34.4 p. ct., asphalt and loss, 13 p. ct. Pyridine base equals 1.75 p. ct.
250	Do	.....	7.3	0.7368	[a]19.5	.8140	73.2	.....	100.0	.....	.....	12.4	.....	.....	.....	[a] At 330° C., gas distillates 25 p. ct., sp. gr. 0.8861; lubricating oil, 35.8 p. ct., sp. gr. 0.9091. Pyridine base equals 2.3 p. ct.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Ventura County—Continued.								
	Sespe district—Continued.								
251	Four Forks		Well	Sespe No. 2		0.8590	33.0		
252	Do		Tar Creek			.8330	38.1		
253	Do		do			.9125	23.4		
254	Do		do			.9129	23.3		
255	Do					.9196	22.2		
256	Do			Kentuck		.9015	25.3		
257	Four Forks; California Oil Co		Well			.9402	18.9		
258	Four Forks; Union Oil Co		do	7	1,175	.8701	30.9		
259	Piru district; Modelo Oil Co			22	1,100	.8838	28.4		
260	Piru district; sec. 8, T. 4 N., R. 18 W		Tank			.8940	26.6		
261	One-half m. west of Santa Paula; Scott & Gilmore					.9302	20.5		
262	Do					.9486	17.6		
263	Limekiln Canyon; Eureka Oil Co					.8905	29.0		

251, 252. California State Min. Bur. Seventh Ann. Rept., 1887. W. D. Johnston, chemist.
253–257. California State Min. Bur. Bull. 11. Laboratory analyses.
258–259. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
261–262. California State Min. Bur. Bull. 11. Laboratory analyses.
263. U. S. Geol. Survey Mineral Resources, 1896, p. 844, 1897. Frederick Salathe, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.									
	CALIFORNIA—Continued.														
	Ventura County—Contd.														
	Sespe district—Contd.														
251	Four Forks	.....	27.1	0.7317	28.8	0.8271	44.1	.....	100.0	.....	.....	.....	.....	.....	.....	Below 100° C., 9.1 p. ct., sp. gr. 0.700; 100°–125° C., 9.2 p. ct., sp. gr. 0.734; 150°–200° C., 11.8 p. ct., sp. gr. 0.798; 200°–250° C., 9. p. ct., sp. gr. 0.822.
252	Do	.....	22.3	.7447	27.8	.8480	49.9	.....	100.0	.....	.....	.....	.....	.....	.....	Below 100° C., 10 p. ct., sp. gr. 0.720; 100°–150° C., 6.8 p. ct., sp. gr. 0.755; 150°–200° C. 9.7 p. ct., sp. gr. 0.809; 200°–250° C., 11 p. ct., sp. gr. 0.856.
253	Do	.....	7.6	.735	33.8	.8118	58.6	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 6 p. ct., sp. gr. 0.8834.
254	Do	.....	8.4	.7240	32.6	.8117	59.0	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 4 p. ct.
255	Do	.....	Tr.	.....	33.4	.8044	66.6	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 6.6 p. ct., sp. gr. 0.8604.
256	Do	.....	6.0	.7200	30.8	.8082	63.2	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 2.5 p. ct., sp. gr. 0.8662.
257	Four Forks; California Oil Co.	.....	Tr.	.....	28.1	.8112	71.9	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 2.9 p. ct., sp. gr. 0.8608.
258	Four Forks; Union Oil Co.	.....	19.5	.7353	30.0	.8299	50.5	.....	100.0	.....	.....	13.2	.....	.....	.....	300° C. to asphalt, 34.9 p. ct., sp. gr. 0.8769. Viscosity by Redwood viscometer 77 at 15° C.
259	Piru district; Modelo Oil Co.	.....	23.3	.7523	35.5	.8514	41.2	.....	100.0	.....	.....	16.6	.....	.....	.....	300° C. to asphalt, 24.2 p. ct., sp. gr. 0.8911. Viscosity by Redwood viscometer 63 at 15° C.
260	Piru district; sec. 8, T. 4 N., R. 18 W.	.....	13.8	.7392	a32.4	.8197	53.8	.....	100.0	.....	.....	12.9	.....	.....	.....	a 150°–270° C.; above 270° C., 38.9 p. ct.
261	One-half m. west of Santa Paula; Scott & Gilmore.	.....	Tr.	.....	28.0	.8272	72.0	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 3.2 p. ct.
262	Do	.....	Tr.	.....	6.0	.8465	94.0	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 7.6 p. ct.
263	Limekiln Canyon; Eureka Oil Co.	.....	14.1	.....	26.4	.....	59.5	.....	100.0	.....	.....	.....	.....	.....	.....	Gas distillate, 24 p. ct.; lubricating distillate, 27 p. ct.; asphalt and loss, 8.5 p. ct. Pyridine base equals 1.44 p. ct.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Ventura County—Continued.								
264	Whider Canyon, 12 miles northwest of Santa Paula; Burrows & Sons.		Well	6	958	0.8767	29.7		
265	Do		Garrett tunnel		1,000	.8828	28.6		
266	Ojai district; Whidden Double		Well	4	284	.9759	13.5		
267	Salt Marsh Canyon (near Santa Paula); Union Oil Co.		do	11		.9351	19.7		
268	Timber Canyon (near Santa Paula); Los Angeles Pacific Ry. Co.		do	3		.8481	35.1		
269	Santa Paula district; Los Angeles Pacific Ry. Co.		do	Capital crude 20	1,000	.8900	27.3		
270	Santa Paula district; sec. 11, T. 4 N., R. 22 W.		Tank			.9873	11.8		
271	Santa Paula district		Well			.9021	25.2	Green	
272	Do		Pipe line			.8997	25.6		
273	Do		Well			.8974	26.0		
274	Do		do			.8929	26.8		

264, 266, 267. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
268. California State Min. Bur. Bull. 31. Paul W. Prutzman.
269. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
270–275. California State Min. Bur. Bull. 31. Paul W. Prutzman.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300° C.	
	CALIFORNIA—continued.														
	Ventura County—Contd.														
264	Whider Canyon, 12 miles northwest of Santa Paula; Burrows & Sons.	.....	26.6	0.7305	27.4	0.8431	46.0	.....	100.0	0.72	.....	14.8	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 30 p. ct., sp. gr. 0.892. Calorific value per c. c., 9,332. Viscosity by Redwood viscometer 77 at 15° C.
265	Do	.....	12.3	.7798	44.6	.8437	43.1	.....	100.0	.....	.....	6.2	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 37.3 p. ct., sp. gr. 0.9014. Viscosity by Redwood viscometer 53 at 15° C.
266	Ojai district; Whidden Double.	.....	0	.....	31.0	.8620	69.0	.....	100.0	1.48	.....	38.1	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 30.8 p. ct. sp. gr. 0.8925. Calorific value per c. c. 8,892. Viscosity by Redwood viscometer over 1,800 at 15° C.
267	Salt Marsh Canyon (near Santa Paula); Union Oil Co.	.....	10.1	.7571	25.9	.8558	64.0	.....	100.0	.....	.....	20.7	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt, 40.1 p. ct., sp. gr. 0.9156. Viscosity by Redwood viscometer 878 at 15° C.
268	Timber Canyon (near Santa Paula); Los Angeles Pacific Rwy. Co.	.....	30.3	.7318	29.3	.8324	40.4	.....	100.0	.....	.....	10.6	.....	.....	.....	All gravities at 15° C. 300° C. to asphalt 28 p. ct., sp. gr. 0.8875. Viscosity by Redwood viscometer 45.8 at 15.5° C.
269	Santa Paula district; Los Angeles Pacific Rwy. Co.	.....	25.8	.7545	28.6	.8535	4.46	.....	100.0	.....	.....	13.0	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt 31.8 p. ct., sp. gr. 0.9154. Viscosity by Redwood viscometer 61.6 at 15° C.
270	Santa Paula district; sec. 11, T. 4 N., R. 22 W.	.....	0	.....	0	(a)	100.0	.....	100.0	.....	.....	41.7	.....	.....	.....	a 150°–270° C.; above 270° C. 56 p. ct., sp. gr. 0.905.
271	Santa Paula district	.....	12.5	.7621	a25.5	.8353	62.0	.....	100.0	.....	.....	11.8	.....	.....	.....	a 150°–270° C.; above 270° C. 50.2 p. ct., sp. gr. 0.915.
272	Do	.....	10.0	.7427	a24.0	.8163	66.0	.....	100.0	.....	.....	25.3	.....	.....	.....	a 150°–270° C.; above 270° C. 38 p. ct., sp. gr. 0.8767.
273	Do	.....	10.0	.7527	a27.0	.8294	63.0	.....	100.0	.....	.....	16.0	.....	.....	.....	a 150°–270° C.; above 270° C. 44 p. ct., sp. gr. not given.
274	Do	.....	13.0	.7609	a26.5	.8284	60.5	.....	100.0	.....	.....	11.0	.....	.....	.....	a 150°–270° C.; above 270° C. 45.9 p. ct.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Ventura County—Continued.								
275	Santa Paula district; sec. 17, T. 4 N., R. 21 W.		Tank			0.8895	27.4		
276	Sulphur Mountain district; Wheeler Canyon		Tunnel						
277	Sulphur Mountain district; Sulphur Mountain Petroleum Co.		Well	1	2,150	.9486	17.6		
278	Sulphur Mountain district		Pinkerton tunnel			.9333	20.0	Green	
279	Do		do			.9398	19.0		
280	Do		do			.9333	20.0	Green	
281	Do		Magie tunnel			.9773	13.3		
282	West of Santa Paula		Well	O'Hara		.9435	18.4		
283	Do		do			.9769	13.3		
284	Silverthread district					.9366	19.5		
285	Do					.9255	21.3		
286	Do					.9369	19.4		
287	Do					.9442	18.3		
288	Do					.9590	16.0		
289	Torrey Canyon district; Union Oil Co.		Well	52	1,410	.8758	29.9		

276. Am. Jour. Sci., 3 ser., vol. 48, p. 252. S. F. Peckham.
277. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.
278-288. California State Min. Bur. Bull. 11. Analyst not given.
289. California State Min. Bur. Bull. 31. H. N. Cooper, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.						
	CALIFORNIA—continued.														
	Ventura County—Contd.														
275	Santa Paula district; sec. 17, T. 4 N., R. 21 W.	.....	19.4	0.7400	a26.1	0.8230	54.5	.....	100.0	.....	.....	18.8	.....	.....	.....	a 150°–270° C.; above 270° C. 35.2 p. ct.
276	Sulphur Mountain district; Wheeler Canyon.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Average composition, hydrogen, 11.819 p. ct.; carbon, 86.934 p. ct.; nitrogen, 1.1095 p. ct.
277	Sulphur Mountain district; Sulphur Mountain Petroleum Co.	.....	7.9	.7576	44.3	.8702	47.8	.....	100.0	.....	.....	25.0	.....	.....	.....	Gravities at 15° C. 300° C. to asphalt 20 p. ct., sp. gr. 0.9302. Viscosity by Redwood viscometer 2,240 at 15° C.
278	Sulphur Mountain district.	.....	.....	.....	27.6	.8242	72.4	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 5 p. ct., sp. gr. 0.862.
279	Do.	.....	Tr.	.....	26.8	.8351	74.2	.....	101.0	.....	.....	.....	.....	.....	.....	300°–350° C., 5 p. ct., sp. gr. 0.8701.
280	Do.	.....	Tr.	.....	27.6	.8242	73.4	.....	101.0	.....	.....	.....	.....	.....	.....	300°–350° C., 5 p. ct., sp. gr. 0.8620.
281	Do.	.....	Tr.	.....	Tr.	.....	100.0	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 16 p. ct., sp. gr. 0.8701.
282	West of Santa Paula.	.....	Tr.	.....	26.4	.8252	73.6	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 6 p. ct., sp. gr. 0.8738.
283	Do.	.....	Tr.	.....	13.0	.8530	87.0	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 3 p. ct.
284	Silverthread district.	.....	5.0	.7560	23.2	.8006	71.8	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 5.8 p. ct., sp. gr. 0.8764.
285	Do.	.....	7.0	.7428	28.2	.8007	64.8	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 6.4 p. ct., sp. gr. 0.8612.
286	Do.	.....	Tr.	.....	34.2	.8157	65.8	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 7.6 p. ct., sp. gr. 0.8791.
287	Do.	.....	Tr.	.....	27.6	.8117	72.4	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 4 p. ct., sp. gr. 0.8790.
288	Do.	.....	Tr.	.....	5.0	.8500	95.0	.....	100.0	.....	.....	.....	.....	.....	.....	300°–350° C., 7 p. ct., sp. gr. 0.8780.
289	Torrey Canyon district; Union Oil Co.	.....	18.7	.7394	28.1	.8312	53.2	.....	100.0	0.71	.....	16.6	.....	.....	.....	300° C. to asphalt, 33.7 p. ct., sp. gr. 0.8720. Calorific value per c. c., 9,293. Viscosity by Redwood viscometer 103 at 15° C.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	CALIFORNIA—continued.								
	Ventura County—Continued.								
290	Torrey Canyon district					0.8650	31.9	Dark reddish brown.	
291	Do					.8917	27.0		
292	Do		Tank			.9174	22.6		
293	Do		Well			.9097	23.9		
294	Do		do			.8855	28.1		
	COLORADO.								
295	Boulder County					.8304	38.6		
296	Fremont County, Florence					.8696	31.0	Dark green	
297	Do		Well		2,455	.8750	30.0		

290. Pet. Rev., Dec. 27, 1906. Clifford Richardson.
291. U. S. Geol. Survey Mineral Resources, 1896, p. 844, 1897; from California State Min. Bur. Bull. 11. Frederick Salathe, chemist.
292–294. California State Min. Bur. Bull. 31. Paul W. Prutzman.
295. U. S. Geol. Survey Mineral Resources, 1901, p. 560, 1902. R. G. Hoffman, F. Salathe.
296. Pet. Rev., Nov. 24, 1896. Clifford Richardson.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	CALIFORNIA—continued.															
	Ventura County—Continued.															
290	Torrey Canyon district..	47	18.4	0.7418	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[a] 47°–116° C., 6 p. ct., sp. gr. 0.7200, refractive index 1,412; 116°–145° C., 12.4 p. ct., sp. gr. 0.7523, refractive index 1.428. Under 26 mm. pressure 36°–94° C., 12.7 p. ct., sp. gr. 0.7912, refractive index 1.440; 94°–132° C., 14 p. ct., sp. gr. 0.8255, refractive index 1.458; 132°–195° C., 17.6 p. ct., sp. gr. .8520, refractive index 1.475; 195°–242° C., 15 p. ct., sp. gr. 0.8808, refractive index 1.491; 242°–280° C., 15 p. ct., sp. gr. 0.8981 (at 40° C.), refractive index 1.504; 280°–310° C., 6.2 p. ct. (solid hydrocarbon), sp. gr. 0.9156, refractive index 1.523.
291	Do.....	.....	9.2	.....	21.5	.....	69.3	.....	100.0	.....	.....	.....	.....	.....	.....	No temperature given. Gas distillate, 26 p. ct.; lubricating distillate, 30.3 p. ct.; asphalt and loss, 13 p. ct. Pyridine bases equal 1.52 p. ct.
292	Do.....	.....	0	.....	[a]30.0	0.8294	70.0	.....	100.0	.....	.....	15.4	.....	.....	.....	[a] 150°–270° C.; above 270° C., 53.2 p. ct.
293	Do.....	.....	7.2	.7609	[a]26.7	.8333	66.1	.....	100.0	.....	.....	25.5	.....	.....	.....	[a] 150°–270° C.; above 270° C., 38.9 p. ct.
294	Do.....	.....	16.6	.7621	[a]23.6	.8245	59.8	.....	100.0	.....	.....	21.1	.....	.....	.....	[a] 150°–270° C.; above 270° C., 35.7 p. ct.
	COLORADO.															
295	Boulder County.....	.....	16.0	.7368	40.0	.8000	44.0	.....	100.0	.....	.....	.....	.....	.....	.....	Burning oil, 150° F. fire test.
296	Fremont County, Florence..	.....	.....	.....	35–40	.....	.....	.....	.....	.....	10.4	.....	.....	19.0	.....	Fixed carbon, 1.6; character of residuum, soft; loss, 200° C. (7 hours), 2.4 p. ct.
297	Do.....	122	1.5	.....	27.0	.7988	70.2	0.9079	98.7	.....	9.23	.....	.....	.....	.....	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	COLORADO—continued.								
	Mesa County.								
298	De Beque	D. T. Day	Well		150	0.8345	37.75	Yellow	Aromatic.
299	Three-fourths mile northwest of De Beque	E. B. Woodruff	do	1		.8997	25.6	Greenish brown	Do.
	Rio Blanco County.								
300	Rangely, sec. 21, T. 2 N., R. 102 W	H. S. Gale	do	1		.8092	43.0	Red	Like Pa. oil.
	ILLINOIS.								
	Clark County.								
	Johnson Township:								
301	Weaver lease, sec. 23					.8872	27.8	Olive green	
302	W. D. Misner lease; Pure Oil Co	J. P. Dunlop	Well	6	606	.8631	32.2	Light green	
303	M. Misner lease; Pure Oil Co	do	do	7	610	.8660	31.7	Dark green	
304	Z. E. Brant farm, sec. 26; Ohio Oil Co	do	do	2	480	.8680	31.3	Light green	
305	Do	do	do	5	474	.8700	30.9	Medium green	
306	Ohio Oil Co., Martinsville	do	Pipe line			.8780	29.5	Light green	
307	Northern part; Ohio Oil Co., Martinsville	do	do			.8761	29.8	Medium green	
	Parker Township:								
308	Briscoe lease, sec. 29					.8730	30.4	Olive green	

301, 308. Illinois State Geol. Survey Bull. 2. F. F. Grout, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.								
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	COLORADO—continued.														
	Mesa County.														
298	Debeque	145	1.0	.....	42.0	0.7188	56.5	0.8427	93.5	.....	19.65	.....	.....	12.4	4.0	
299	Three-fourths mile northwest of Debeque.	225	.....	.....	27.0	.7471	70.9	.8511	97.9	.....	27.23	.....	.....	.....	.....	
	Rio Blanco County.														
300	Rangely, sec. 21, T. 2 N., R. 102 W.	48	28.0	0.680	42.0	.751	30.0	.....	100.0	.....	.....	.....	.....	.....	.....	
	ILLINOIS.														
	Clark County.														
	Johnson Township:														
301	Weaver lease, sec 23	88	4.4	.7450	33.2	.8120	62.4	.....	100.0	0.13	.....	.....	.....	.....	.....	Sp. gr. of lubricating oil, 0.863; coke and loss, 12.4 p. ct.
302	W. D. Misner lease; Pure Oil Co.	75	11.5	.7318	35.0	.8174	53.5	.....	100.0	.....	.....	.....	.....	.....	.....	Lower sand oil.
303	M. Misner lease; Pure Oil Co.	75	8.0	.7193	32.0	.8065	60.0	.....	100.0	.30	.....	.....	.....	.....	.....	Do.
304	Z. E. Brant farm, sec. 26; Ohio Oil Co.	75	10.5	.7261	30.5	.8141	59.0	.....	100.0	.27	.....	.....	.....	.....	.....	Upper sand oil.
305	Do	75	10.0	.7275	33.0	.8186	57.0	.....	100.0	.24	.....	.....	.....	.....	.....	Do.
306	Ohio Oil Co., Martinsville.	70	10.0	.7326	33.0	.8183	57.0	.....	100.0	.23	.....	.....	.....	.....	.....	
307	Northern part; Ohio Oil Co., Martinsville.	80	11.0	.7371	29.5	.8147	59.5	.....	100.0	.26	.....	.....	.....	.....	.....	
	Parker Township:														
308	Briscoe lease, sec. 29	.....	8.6	.741	34.8	.8138	56.6	.....	100.0	.73	.....	.....	.....	.....	.....	Sp. gr. of lubricating oil, 0.853; coke and loss, 8.6 p. ct.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	ILLINOIS—continued.								
	Clark County—Continued.								
	Parker Township—Continued.								
	Oil-field pool—								
309	S. Spellbring farm, sec. 7; Ohio Oil Co	J. P. Dunlop	Well	7	330	0.8460	35.5	Light green	Hydrogen sulphide.
310	M. K. Young farm, sec. 18; Ohio Oil Co	do	do	27	330	.8460	35.5	do	Do.
311	G. H. Jeffries farm, sec. 20; Ohio Oil Co	do	do	21	325	.8530	34.1	do	Do.
	Parker Township pool—								
312	J. Turner lease, sec. 33; Ohio Oil Co	do	do	2, 4, 5, 6, 7, 10	300	.8790	29.3	Medium green	Do.
313	Do	do	do	12	300	.8790	29.3	Brown	Do.
314	Kelly farm, sec. 33; Treat & Crawford	do	do	1, 2, 3, 4	300	.8650	31.9	Light green	Do.
315	N. J. Linn farm; Mars Oil & Gas Co	do	do	1–9	280–320	.8568	33.4	do	Do.
	Casey Township:								
316	Ohio Oil Co., Casey	Ohio Oil Co	do	79	2,450	.8299	38.7	Dark green	Sulphur.
	Crawford County.								
	Oblong Township:								
317	Birch lease					.870	30.9	Olive green	

317. Illinois State Geol. Survey Bull. 2. F. F. Grout, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°-300° C.		Residuum.		Total.					Crude	150°-300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	ILLINOIS—continued.															
	Clark County—Continued.															
	Parker Township—Contd.															
	Oil-field pool—															
309	S. Spellbring farm, sec. 7; Ohio Oil Co.	63	14.0	0.7745	31.0	0.8145	55.0	.....	100.0	0.48	.....	.....	.....	.....	.....	
310	M. K. Young farm, sec. 18; Ohio Oil Co.	55	10.5	.7357	34.0	.8184	55.5	.....	100.0	.35	.....	.....	.....	.....	.....	
311	G. H. Jeffries farm; sec. 20; Ohio Oil Co.	55	15.5	.7323	30.5	.8173	54.0	.....	100.0	.47	.....	.....	.....	.....	.....	
	Parker Township pool—															
312	J. Turner lease, sec. 33; Ohio Oil Co.	65	8.5	.7557	25.0	.8278	66.5	.....	100.0	.30	.....	.....	.....	.....	.....	
313	Do.....	65	8.0	.7008	27.0	.8268	65.0	.....	100.0	.37	.....	.....	.....	.....	.....	
314	Kelly farm, sec. 33; Treat & Crawford.	75	11.5	.7433	30.5	.8193	58.0	.....	100.0	.48	.....	.....	.....	.....	.....	
315	N. J. Linn farm; Mars Oil & Gas Co.	65	14.0	.7473	25.0	.8216	61.0	.....	100.0	.38	.....	.....	.....	.....	.....	
	Casey Township:															
316	Ohio Oil Co., Casey.....	85	8.0	.7222	33.0	.7833	56.1	0.8861	97.1	.....	.....	.....	.....	.....	.....	
	Crawford County.															
	Oblong Township:															
317	Birch lease.....	60	3.5	.749	36.8	.8060	59.7	.....	100.0	.10	.....	.....	.....	.....	.....	Sp. gr. of lubricating oil, 0.849; coke and loss, 9.5 p. ct.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	ILLINOIS—continued.								
	Crawford County—Continued.								
	Robinson pool:								
318	Mitchell Oil Co.	J. P. Dunlop.	Well	1, 2, 3	950	0.8460	35.5	Medium green.	
319	Graswald lease; G. E. Thomas	do	do	1	970	.8542	33.9	Light green.	
320	Miller lease; Fisher Oil Co	do	do	2	945	.8712	30.7	do	
321	Quick lease; John Markham	do	do	7	960	.8380	37.0	Dark green.	
322	E. E. Newlin farm, 2¼ miles west of Robinson		do	6		.8375	37.1	Brown	
	Montgomery Township:								
	Duncansville pool—								
323	J. W. Creswell	J. P. Dunlop.	do	1	970	.9150	23.0	do	
324	Higgins lease; M. Bernstein Co	do	do	1	965	.9192	22.3	do	
325	Martinsville, Ohio Oil Co	do	Pipe-line			.8552	33.7	Light green.	
326	W. C. Jones, Robinson, NW. cor. NW. ¼ sec. 28, T. 7, R. 2.	W. C. Jones	Well	1	1,140	.8490	34.9	Dark green.	
	Cumberland County.								
	Union Township:								
327	Queen farm, sec. 13; Campbell, McElroy & Bell	J. P. Dunlop.	Pipe-line	5, 8, 9, 10, 11, 13, 21	400	.8390	36.9	Light green.	
328	Do	do	Well	1, 2, 3, 4, 17, 18, 19.	400	.8410	36.5	do	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.						
	ILLINOIS—continued.														
	Crawford County—Continued.														
	Robinson pool:														
318	Mitchell Oil Co	80	8.0	0.7183	39.0	0.7941	53.0	.....	100.0	0.16	.....	.....	.....	.....	.....
319	Graswald lease; G. E. Thomas.	60	16.0	.733	34.0	.8135	50.0	.....	100.0	.17	.....	.....	.....	.....	.....
320	Miller lease; Fisher Oil Co.	80	11.5	.7531	32.0	.8266	56.5	.....	100.0	.19	.....	.....	.....	.....	.....
321	Quick lease; John Markham.	51	20.0	.7705	32.0	.8107	48.0	.....	100.0	.15	.....	.....	.....	.....	.....
322	E. E. Newlin farm, 2½ miles west of Robinson.	69	13.0	.728	33.0	.7954	52.1	0.9132	98.1	.....	2.57	.74	(a)	.....	.....	a Present
	Montgomery Township:														
	Duncansville pool—														
323	J. W. Creswell	80	1.0	.....	24.5	.8391	74.5	.....	100.0	.39	.....	.....	.....	.....	.....
324	Higgins lease; M. Bernstein Co.	75	4.0	.....	20.0	.8507	76.0	.....	100.0	.39	.....	.....	.....	.....	.....
325	Martinsville, Ohio, Oil Co	75	15.0	.7338	37.0	.8103	48.0	.....	100.0	.17	.....	.....	.....	.....	.....
326	W. C. Jones, Robinson, NW. cor. NW. ¼ sec. 28, T. 7, R. 2.	95	13.0	.7386	37.0	.8028	50.0	.9235	100.0	.....	3.71	1.56	.....	.....	.....
	Cumberland County.														
	Union Township:														
327	Queen farm, sec. 13; Campbell, McElroy & Bell.	60	18.0	.7211	38.0	.8146	44.0	.....	100.0	.20	.....	.....	.....	.....	.....	Oil from first sand.
328	Do	60	18.0	.7201	30.0	.8071	52.0	.....	100.0	.24	.....	.....	.....	.....	.....	Do.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	ILLINOIS—continued.								
	Cumberland County—Continued.								
	Union Township—Continued.								
329	Underwood lease, sec. 13, Ohio Oil Co	J. P. Dunlop	Well	17	577	0.8780	29.5	Light green	
330	Siggins pool, Ohio Oil Co., Martinsville	do	Pipe line			.8690	31.1	Medium green	
	Lawrence County.								
	Petty Township:								
	Bridgeport pool—								
331	W. E. Neil lease; Braden Oil Co	J. P. Dunlop	Well	3	1,435	.8330	38.1	Light green	
332	Eshelman lease; Bridgeport Oil Co	do	do	2	900	.8542	33.9	Dark green	
333	Do	do	do	4	900	.8642	32.0	do	
334	Thorn lease; Ohio Oil Co	do	do	2, 12	1,300	.8552	33.7	Medium green	
335	Do	do	do	13, 11, 17	1,300	.8552	33.7	do	
336	Do	do	do	8, 10	1,300	.8563	33.5	Light green	
337	Macpherson lease (100 acres); Kirkwood Oil Co.	do	do	1	1,500	.8280	39.1	Dark green	
338	Macpherson lease (20 acres); Kirkwood Oil Co.	do	do	1	1,500	.8290	39.5	Medium green	
339	Snowden Bros. & Co., Bridgeport					.8309	38.5		

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.													
			To 150° C.		150°-300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°-300°C.	
	ILLINOIS—continued.															
	Cumberland County—Contd.															
	Union Township—Contd.															
329	Underwood lease, sec. 13, Ohio Oil Co.	80	10.1	0.719	34.0	0.8215	55.9	.....	100.0	0.33	.....	.....	.....	.....	.....	Lower sand oil contains 8 p. ct. water.
330	Siggins pool, Ohio Oil Co., Martinsville.	80	13.0	.7268	33.0	.7983	54.0	.....	100.0	.19	.....	.....	.....	.....	.....	
	Lawrence County.															
	Petty Township:															
	Bridgeport pool—															
331	W. E. Neil lease; Braden Oil Co.	.....	21.0	.7106	33.0	.811	46.0	.....	100.0	.17	.....	5.04	.....	.....	.....	Lower Bridgeport sand.
332	Eshelman lease; Bridgeport Oil Co.	47	15.0	.7175	32.0	.8211	53.0	.....	100.0	.24	.....	.....	.....	.....	.....	Upper sand.
333	Do.	70	14.5	.7197	31.0	.8218	54.5	.....	100.0	.....	.....	.....	.....	.....	.....	Do.
334	Thorn lease; Ohio Co.	75	16.5	.7193	31.0	.794	52.5	.....	100.0	.....	.....	.....	.....	.....	.....	Buchanan sand.
335	Do.	68	16.5	.7265	41.0	.8193	42.5	.....	100.0	.20	.....	.....	.....	.....	.....	Do.
336	Do.	75	14.0	.7248	32.0	.8188	54.0	.....	100.0	.21	.....	.....	.....	.....	.....	Do.
337	Macpherson lease (100 acres); Kirkwood Oil Co.	45	21.0	.7313	25.0	.8103	54.0	.....	100.0	.13	.....	.....	.....	.....	.....	
338	Macpherson lease (20 acres); Kirkwood Oil Co.	40	23.0	.7113	31.5	.8101	45.5	.....	100.0	.17	.....	.....	.....	.....	.....	
339	Snowden Bros. & Co., Bridgeport.	.....	16.8	.....	31.2	.....	52.0	.....	100.0	.....	.....	.....	.....	.....	.....	From statistical report to U. S. Geological Survey in 1907.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	ILLINOIS—continued.								
	Lawrence County—Continued.								
	Petty Township—Continued.								
340	Geo. Cooper farm, Indian Refining Co., Lawrenceville.	Indian Refining Co.	Well		1,700	0.8475	35.2	Dark green	Sulphur.
341	Ohio Oil Co., Martinsville	J. P. Dunlop	Pipe line			.8470	35.3	Light green	
	Bridgeport Township:								
342	C. Cummings farm, Indian Refining Co., Lawrenceville.	Indian Refining Co.	Well		1,700	.8289	38.9	Dark green	Do.
	Lawrence Township:								
343	R. M. Kirkwood farm, Indian Refining Co., Lawrenceville.	do	do		1,700	.8378	37.1	do	Do.
	Macoupin County.								
344	Rinaker & Rinaker		Well			.8917	27.0	Black	
	Marion County.								
345	Near Junction City, NW. ¼ sec. 32, T. 2 N., R. 1 E.	C. S. Jennings	Well	2	565	.8557	33.6	Dark green	
346	Do	do	do	3	561½	.8626	32.3	do	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°-300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°-300°C.	
	ILLINOIS—continued.														
	Lawrence County—Contd.														
	Petty Township—Contd.														
340	Geo. Cooper farm, Indian Refining Co., Lawrenceville.	110	6.0	0.7480	40.0	0.7944	54.2	0.9021	100.2	.....	1.96	.....	Tr.	.....	.....	Green oil sand.
341	Ohio Oil Co., Martinsville.	71	15.0	.7276	34.0	.8053	51.0	.....	100.0	0.17	.....	.....	.....	.....	.....	
	Bridgeport Township:														
342	C. Cummings farm, Indian Refining Co., Lawrenceville.	73	12.0	.7230	35.0	.7874	49.2	.9067	96.2	.....	4.31	.....	Tr.	.....	.....	Do.
	Lawrence Township:														
343	R. M. Kirkwood farm, Indian Refining Co., Lawrenceville.	90	13.0	.7305	32.0	.7844	51.9	.9044	96.9	.....	3.30	.....	Tr.	.....	.....	Do.
	Macoupin County.														
344	Rinaker & Rinaker.....	155	.....	.....	21.0	.8283	74.7	.9530	98.7	.....	.....	.....	2.74	.....	.....	
	Marion County.														
345	Near Junction City, NW. ¼ sec. 32, T. 2 N., R. 1 E.	95	6.5	.7390	34.0	.7815	57.3	.9168	97.8	.....	4.21	0.53	.....	.....	.....	
346	.....do.....	108	3.5	.7430	36.5	.7887	59.2	.9132	99.2	.....	5.48	.38	.....	.....	.....	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	ILLINOIS—continued.								
	Montgomery County.								
347	Litchfield					0.9236	21.6		
	Randolph County.								
348	Sparta					.8420	36.3		
	INDIANA.								
349	Dubois County, Birdseye					.8500	34.7		
350	Grant County, Van Buren					.8531	34.1		
351	Jasper County					.9280	20.9		
352	Do		Refinery run			.9371	19.4		
353	Vigo County, Terre Haute					.8790	29.8		

347, 348. Illinois State Geol. Survey Bull. 2. F. F. Grout, analyst.
349. Indiana Dept. Geol. and Nat. Resources Repts., 1903. Analysis by chemist of St. Louis Sampling & Testing Works
350. Indiana Dept. Geol. and Nat. Resources Repts., 1901. W. A. Noyes, analyst.
351. Indiana Dept. Geol. and Nat. Resources Repts., 1903. Mariner and Hoskins, analysts.
352. Indiana Dept. Geol. and Nat. Resources Repts., 1904. R. Levering.
353. Indiana Dept. Geol. and Nat. Resources Repts., 1901. W. A. Noyes, Analyst.

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Analyses of petroleum from various parts of the United States—Continued

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°-300° C.		Residuum.		Total.					Crude	150°-300° C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	ILLINOIS—continued.															
	Montgomery County.															
347	Litchfield	110	1.3	(a)	16.9	0.852	81.8	.....	100.0	.....	.....	.....	.....	.....	.....	Sp. gr. of lubricating oil, 0.863; coke and loss, 10.7 p. ct.; sample out of ground some months. (a) Specimens too small to test.
	Randolph County.															
348	Sparta	.....	14.0	0.729	37.0	.7972	49.0	.....	100.0	.....	.....	.....	.....	.....	.....	Sp. gr. of lubricating oil, 0.850; coke and loss, 7 p. ct.; sample had stood some time; burning point, 22° C.
	INDIANA.															
349	Dubois County, Birdseye	.....	17.4	.....	26.9	.....	55.5	.....	99.8	.....	.....	.....	.....	.....	.....	Lubricating oil, 42.2 p. ct.; residium, 13.3 p. ct.; sample from Southern Oil Co., Evansville, Ind.
350	Grant County, Van Buren	.....	7.2	.719	32.6	.7965	60.2	.....	100.0	0.83	.....	.....	.....	.....	.....	300°-350° C., 14.8 p. ct.; sp. gr., 0.844; 350°-390° C., 41.8 p. ct.; sp. gr., 0.860.
351	Jasper County	.....	.....	.....	.....	.....	97.0	.....	97.0	1.26	.....	2.9	.....	.....	.....	Cold test, 7° F.; fire test, 437° F.
352	Do	248	.....	.....	.....	.....	.....	.....	100.0	.....	.....	47.0	.....	.....	.....	Total distillates obtained when running crude down to asphalt, 49 p. ct.; loss, 4 p. ct.
353	Vigo County, Terre Haute	.....	.....	.....	39.6	.8254	60.4	.....	100.0	.72	.....	.....	.....	.....	.....	300°-350° C., 14.8 p. ct.; sp. gr., 0.867; 350°-390° C., 40.6 p. ct.; sp. gr., 0.879.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	KANSAS.								
	Allen County.								
	Humboldt pool:								
354	McKinley Crude Oil Co., Humboldt	J. P. Dunlop	Settling tank			0.8878	27.7	Dark green	
355	McKinley Crude Oil Co., Humboldt, Logan Township.	do	Well	11	851	.8895	27.4	Black	
356	Fussman lease, Logan Township, Frank Fussman, Humboldt.	do	do	1	850	.8822	28.7	do	
357	Do	do	do	3	850	.8850	28.2	do	
	Chanute pool:								
358	Hedrich lease, I. N. Knapp, Chanute	do	do	6	700	.8706	30.8	Dark green	
359	Beach lease, Rex Oil and Gas Co., Chanute	do	do	16	751	.8647	31.9	do	
360	Do	do	do	12	737	.8647	31.9	do	
361	Kansas Cooperative Refining Co., Chanute	do	Tank			.8615	32.5	Black	
362	Chanute Refining Co., Chanute	do	Pipe line			.8637	32.1	Dark brown	
	Moran pool:								
363	Carroll lease, Eastern Kansas Oil Co., Moran	do	Well	4	735	.8794	29.2	Black	
364	Smith lease, Eastern Kansas Oil Co., Moran	do	do	2	735	.8799	29.1	do	
365	Newton lease, E. F. Holman, Moran	do	do	5	735	.8712	30.7	do	
366	Eastern Kansas Oil Co., Moran	do	Pipe line			.8589	33.0	do	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°-300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°-300°C.	
	KANSAS.															
	Allen County.															
	Humboldt pool:															
354	McKinley Crude Oil Co., Humboldt.	123	1.0	.....	29.0	0.8152	68.9	0.9247	98.9	.....	3.93	2.33	.....	32.8	2	
355	McKinley Crude Oil Co., Humboldt, Logan Township.	110	3.0	.....	29.0	.8142	67.0	.9284	99.0	.....	1.92	2.68	.....	23.6	6	
356	Fussman lease, Logan Township, Frank Fussman, Humboldt.	108	5.0	0.7460	26.5	.8205	67.4	.9272	98.9	.....	2.10	1.03	.....	29.6	.....	
257	Do.....	85	3.5	.7515	27.0	.8160	67.2	.9284	97.7	.....	7.92	.39	.....	41.2	8	
	Chanute pool:															
358	Hedrich lease, I. N. Knapp, Chanute.	125	3.0	.7500	37.5	.8029	59.3	.9229	99.8	.....	3.78	.89	.....	26.0	1	
359	Beach lease, Rex Oil and Gas Co., Chanute.	109	5.0	.7350	36.0	.7993	57.8	.9223	98.8	.....	4.25	1.23	.....	24.0	1	
360	Do.....	110	6.0	.7375	36.0	.7992	56.6	.9204	98.6	.....	4.71	1.45	.....	22.4	.....	
361	Kansas Cooperative Refining Co., Chanute.	90	7.5	.7156	33.0	.8022	58.7	.9192	99.2	.....	1.45	1.50	.....	24.0	8	
262	Chanute Refining Co., Chanute.	113	4.5	.7405	35.0	.7927	57.2	9174	96.7	.....	4.32	1.15	.....	24.4	8	
	Moran pool:															
363	Carroll lease, Eastern Kansas Oil Co., Moran.	95	8.0	.7275	29.0	.8137	61.0	.9358	98.0	.....	1.21	2.63	.....	19.6	3	
364	Smith lease, Eastern Kansas Oil Co., Moran.	78	10.0	.7105	25.5	.8125	64.5	.9180	100.0	.....	3.48	1.66	.....	29.2	.....	
365	Newton lease, E. F. Holman, Moran.	75	7.5	.7190	25.0	.8135	60.3	.9409	92.8	.....	3.94	2.67	.....	28.0	.....	
366	Eastern Kansas Oil Co., Moran.	106	3.0	.7330	37.0	.7822	59.5	.9192	99.5	.....	4.61	2.32	.....	27.6	6	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	KANSAS—continued.								
	Chautauqua County.								
	Peru pool:								
367	Prairie Oil & Gas Co., Peru station, Independence.	J. P. Dunlop.....	Pipe line.....	.....	.....	0.8526	34.2	Black.....	
368	F. G. Hill's lease, Interstate Oil & Gas Co., Peru..	.....do.....	Well.....	1, 2.....	1,070	.8557	33.6	Dark green.....	
369	Hill's lease, Central Pool Oil Co., Peru.....	.....do.....	Settling tank.....	1–12.....	1,100	.8521	34.3	.....do.....	
370	Interstate lease, Pittsburgh Oil & Gas Co., Peru..	.....do.....	Well.....	1.....	1,100	.8454	35.6	Black.....	
371	Do.....	.....do.....	.....do.....	6.....	1,100	.8500	34.7	.....do.....	
	Elk County.								
	Longton pool:								
372	Allen County Investment Co., Longton.....	J. P. Dunlop.....	Well.....	2.....	585	.8637	32.1	Black.....	
373	Do.....	.....do.....	Settling tank.....	.....	.....	.8631	32.2	.....do.....	
	Franklin County.								
	Rantoul pool:								
374	Springer lease, Hardison & Streeter, Rantoul.....	J. P. Dunlop.....	Well.....	1–4.....	350	.8557	33.6	Black.....	
375	Tullows lease, Hardison & Streeter, Rantoul.....	.....do.....	.....do.....	6.....	350	.8750	30.0	.....do.....	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.						
	KANSAS—continued.														
	Chautauqua County.														
	Peru pool:														
367	Prairie Oil & Gas Co., Peru station, Independence.	87	7.0	0.7244	32.5	0.7934	58.7	0.9150	98.2	.....	3.81	0.35	.....	27.6	5	
368	F. G. Hill's lease, Interstate Oil & Gas Co., Peru.	110	7.0	.7310	37.0	.7975	53.2	.9150	97.2	.....	5.79	1.53	.....	24.8	.....	
369	Hill's lease, Central Pool Oil Co., Peru.	80	12.0	.7160	30.0	.7945	55.5	.9138	97.5	.....	5.24	.20	.....	24.8	3	
370	Interstate lease, Pittsburgh Oil & Gas Co., Peru.	77	11.0	.7218	30.0	.7988	55.3	.9162	96.3	.....	4.54	.42	.....	12.4	6	
371	Do.....	66	13.0	.7177	31.5	.8015	52.5	.9174	97.0	.....	5.41	.34	.....	.....	3	
	Elk County.														
	Longton pool:														
372	Allen County Investment Co., Longton.	98	12.0	.7202	27.5	.7920	59.3	.9229	98.8	.....	7.19	.89	.....	29.6	5	
373	Do.....	96	6.0	.7360	31.0	.7890	59.6	.9198	96.6	.....	4.30	1.56	.....	30.8	.....	
	Franklin County.														
	Rantoul pool:														
374	Springer lease, Hardison & Streeter, Rantoul.	76	11.5	.7116	29.5	.7950	54.9	.9272	95.9	.....	3.45	2.29	.....	34.0	.....	
375	Tullows lease, Hardison & Streeter, Rantoul.	136	1.0	.....	39.0	.7892	60.0	.9358	100.0	.....	3.98	2.80	.....	26.0	2	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	KANSAS—continued.								
	Franklin County—Continued.								
	Rantoul pool—Continued.								
376	Prairie Oil & Gas Co., Pump station, Rantoul	J. P. Dunlop	Tank			0.8578	33.2	Black	
	Kay County.								
377	Newkirk Gas & Mineral Co., Newkirk		Well	1		.8511	34.5		
	Miami County.								
	Paola pool:								
378	C. J. Hafey, Paola	J. P. Dunlop	Well	4	360	.8511	34.5	Black	
	Montgomery County.								
	Coffeyville pool:								
379	Gilroy lease, Brown Brokerage Co., Coffeyville	J. P. Dunlop	Well	1-15	600	.8822	28.7	Dark green	
380	M. Davis lease, Dunkley & Odell, Coffeyville	do	Settling tank	1-40	625	.8717	30.6	Black	
	Wayside pool:								
381	J. Hall lease, Lynch & McSweeney, Wayside	do	Well	1, 2	800	.8696	31.0	do	
382	Do	do	Settling tank			.8838	28.4	do	

377. U. S. Geol. Survey Mineral Resources, 1903, p. 671, 1904. Edwin De Barr, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°-300° C.		Residuum.		Total.								
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°-300°C.	
	KANSAS—continued.														
	Franklin County—Contd.														
376	Rantoul pool—Continued. Prairie Oil & Gas Co., Pump station, Rantoul.	103	5.5	0.7220	33.5	0.7850	59.7	0.9217	98.7	.....	4.34	1.93	.....	26.4	6	
	Kay County.														
377	Newkirk Gas & Mineral Co., Newkirk.	.....	.....	.....	.....	.....	.....	.....	100.0	.....	.....	.....	.....	.....	.....	Below 170° C., 9.1 p. ct.; 170°-315° C., 43.75 p. ct.; lubricating oil, 37 p. ct.; solid oil and residuum, 10.15 p. ct.
	Miami County.														
378	Paola pool: C. J. Hafey, Paola.....	80	10.0	.7202	33.0	.7964	55.8	.9223	98.8	.....	7.44	2.94	.....	19.6	8	
	Montgomery County.														
379	Coffeyville pool: Gilroy lease, Brown Brokerage Co., Coffeyville.	173	.....	.....	31.0	.8082	66.2	.9138	97.2	.....	5.31	.17	.....	22.0	.....	
380	M. Davis lease, Dunkley & Odell, Coffeyville.	100	6.0	.7289	33.0	.8030	58.3	.9241	97.3	.....	.....	.....	.....	24.4	.....	
381	Wayside pool: J. Hall lease, Lynch & McSweeney, Wayside.	75	9.5	.7100	28.0	.8080	59.9	.9396	97.4	.....	4.66	.61	.....	35.6	.....	
382	Do.....	81	5.0	.7315	28.0	.7962	66.0	.9290	99.0	.....	(a)	(a)	.....	50.0	8	a With Kansas 390.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	KANSAS—continued.								
	Montgomery County—Continued.								
	Bolton pool:								
383	G. L. Bank lease, Miller Rider & Co., Independence.	J. P. Dunlop	Well	4	1,180	0.8424	36.2	Black	
384	Prairie Oil & Gas Co., station 5, Independence	do	Pipe line			.8495	34.8	do	
385	Federal Gas & Oil Co., Cherryvale		Well			.8730	30.4		
	Neosho County.								
	Erie pool:								
386	Webb lease, Northland Oil & Gas Co., Erie	J. P. Dunlop	Tank			.8739	30.2	Black	
387	Barger lease, Buckeye Oil & Gas Co., Erie	do	Well	2	520	.8658	31.7	do	
388	Thayer		do	Ordway		.8490	34.9		
	Wilson County.								
	Neodesha pool:								
389	D. Johnson lease, Dolly Johnson Oil & Gas Co., Neodesha.	J. P. Dunlop	Well	13	800	.8373	37.2	Dark green	

385. Pet. Rev., Feb. 2, 1907. Clifford Richardson.
388. Mineral resources of Kansas, 1897. E. H. Bailey, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent)	Paraffin (per cent)	Asphalt (per cent)	Water (per cent)	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°-300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°-300°.	
	KANSAS—continued.															
	Montgomery County—Con.															
383	Bolton pool: G. L. Bank lease, Miller Rider & Co., Independence.	72	14.7	0.7273	31.0	0.8095	49.2	0.9365	94.9	.....	.....	.....	.....	20.0	.....	
384	Prairie Oil & Gas Co., Station 5, Independence.	109	7.0	.7358	36.5	.7982	55.6	.9126	99.1	.....	6.31	0.55	.....	24.0	6	
385	Federal Gas & Oil Co., Cherryvale.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Distillation in vacuo, 20 mm. pressure, 60°-140° C., 16.3 p. ct.; 140°-300° C., 53.9 p. ct. Character of residuum at 200° C., soft, paraffin; 280°-300° C., solid.
	Neosho County.															
	Erie pool:															
386	Webb lease, Northland Oil & Gas Co., Erie.	135	1.0	.....	34.0	.8000	64.1	.9115	99.1	.....	4.78	3.20	.....	27.2	7	
387	Barger lease, Buckeye Oil & Gas Co., Erie.	110	3.0	.....	35.0	.7960	61.8	.9162	99.8	.....	1.22	.88	.....	23.6	2	
388	Thayer.....	.....	16.7	.7282	39.2	.8093	44.1	.8663	100.0	.....	.....	.....	.....	.....	.....	
	Wilson County.															
	Neodesha pool:															
389	D. Johnson lease, Dolly Johnson Oil & Gas Co., Neodesha.	80	17.0	.7172	30.0	.8005	48.6	.9079	95.6	.....	(a)	(a)	.....	18.0	.....	a With Kansas 390.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	KANSAS—continued.								
	Wilson County—Continued.								
	Neodesha pool—Continued.								
390	T. Johnson lease, Prairie Oil & Gas Co., Neodesha.	J. P. Dunlop	Well	3	820	0.8368	37.3	Black	
391	Dolly Johnson Oil & Gas Co., Neodesha	do	Settling tank			.8568	33.4	Dark green	
392	Neodesha		Well	Main		.8350	37.7		
393	Do		do	Kimball		.8350	37.7		
	KENTUCKY.								
	Allen County.								
394	Petroleum pool, Newman farm, Southern Oil & Gas Co., Petroleum.	Cass Burrus for M. J. Munn.	Well		810	.8490	34.9	Brown	Like Pa. oil.
	Bath County.								
395	Ragland pool, Ragland farm, J. W. Radcliffe	J. W. Radcliffe for M. J. Munn.	Well		366	.8963	26.2	do	Do.

392, 393. Mineral resources of Kansas, 1897. E. H. Bailey, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°-300° C.		Residuum.		Total.					Crude	150°-300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	KANSAS—continued.															
	Wilson County—Continued.															
	Neodesha pool—Continued.															
390	T. Johnson lease, Prairie Oil & Gas Co., Neodesha.	88	16.0	0.7158	36.0	0.7925	47.7	0.9091	99.7	.....	a3.40	a0.08	.....	20.0	.....	a Includes Kansas 381 and Kansas 389.
391	Dolly Johnson Oil & Gas Co., Neodesha.	135	1.0	.....	40.5	.7994	57.0	.9109	98.5	.....	5.79	.10	.....	30.0	3	
392	Neodesha.....	.....	19.1	.7205	38.1	.8081	42.8	.....	100.0	.....	.....	.....	.....	.....	.....	
393	Do.....	.....	19.8	.7252	34.8	.8105	45.4	.....	100.0	.....	.....	.....	.....	.....	.....	
	KENTUCKY.															
	Allen County.															
394	Petroleum pool, Newman farm, Southern Oil & Gas Co., Petroleum.	71	12.5	.7373	41.0	.8144	45.3	.9162	98.8	.....	3.65	2.10	Tr.	18.8	7.0	
	Bath County.															
395	Ragland pool, Ragland farm, J. W. Radcliffe.	136	1.0	.....	29.0	.8151	69.6	.9434	99.6	.....	2.13	0	Tr.	30.0	5.0	Ragland sand.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	KENTUCKY—continued.								
	Lawrence County.								
396	Lower Lawrence County		Well		320	0.8531	34.1	Brownish black	
397	Busseyville 1		do			.8104	42.75	Light green	Like Pa. oil.
398	Busseyville 2		do			.8187	41.0	do	Do.
399	Busseyville 3		do			.8226	40.2	do	Do.
	Morgan County.								
400	Buck Run field, Union Township, sec. 11, Harrison farm.	M. W. Crouch	Tank			.8092	43.0	Dark green	Do.
	Ohio County.								
401	West Kentucky Oil Co., Hartford		Well	1	1,777	.8383	37.0	do	Do.
	Wayne County.								
402	Parnell pool, Polly Lair farm, P. M. Burwald, Monticello.	M. W. Crouch	Well	1	692	.8083	43.2	Light green	Do.
403	Sinking pool, Wood Oil Co., Monticello	M. J. Munn	do	Chrisman 1	600	.8154	41.7	Dark green	Do.
404	Oil Valley pool, Ohio & Kentucky Oil Refining Co., Oil Valley.	do	do	4	690	.8154	41.7		Do.

396. Kentucky Geol. Survey, 1888. Robert Peter, chemist.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	Bu volume.													
			To 150° C.		150°-300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°-300°C.	
	KENTUCKY—continued.															
	Lawrence County.															
396	Lower Lawrence County	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Submitted to distillation until 91.4 p. ct. passed over; distillate then fractionally distilled, 160° C., 16.3 p. ct. of original; 160°-320° C., 39 p. ct.
397	Busseyville 1	70	9.5	0.7245	34.5	0.7756	49.4	0.8861	93.4	.....	.....	.....	.....	.....	.....	
398	Busseyville 2	70	7.5	.7100	38.0	.7759	49.5	.8923	95.0	.....	.....	.....	.....	.....	.....	
399	Busseyville 3	73	13.0	.7156	33.0	.7854	49.0	.8917	95.0	.....	.....	.....	.....	.....	.....	
	Morgan County.															
400	Buck Run field, Union Township, sec. 11, Harrison farm.	95	13.0	.7270	35.0	.7796	50.7	.8557	98.7	.....	5.40	0	.....	8.4	6.8	First Cow Run sand.
	Ohio County.															
401	West Kentucky Oil Co., Hartford.	70	7.0	.707	32.0	.7802	57.4	.9201	96.4	.....	3.6	0	Tr.	.....	.....	
	Wayne County.															
402	Parnell pool, Polly Lair farm, P. M. Burwald, Monticello.	43	27.0	.7047	33.0	.8017	37.3	.9061	97.3	.....	2.47	0	.....	14.8	6.0	Sunnybrook sand.
403	Sinking pool, Wood Oil Co., Monticello.	65	22.0	.7273	36.0	.8043	38.6	.9038	96.6	.....	3.73	.56	.....	11.6	2.0	Beaver Creek sand.
404	Oil Valley pool, Ohio & Kentucky Oil Refining Co., Oil Valley.	50	20.0	.7129	36.0	.7989	39.7	.9121	95.7	.....	3.34	1.78	.....	14.8	2.0	Do.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F		Color.	Odor.
						Specific.	Baumé.		
	KENTUCKY—continued.								
	Wayne County—Continued.								
405	Johnson Fork field	M. J. Munn	Well			0.8408	36.5	Brown	Like Pa. oil.
406		do	do			.8235	40.0	Dark green	Do.
407	Cooper pool, B. S. Huffaker farm, Penn Lubricating Co., Monticello.	M. W. Crouch	do	5		.8178	41.2	Black	Do.
408	Turkey Rock pool. Slickford district, Jos. Brown & Co., Slickford.	M. J. Munn	do	Morris 4		.8163	41.5	Dark green	Do.
409	Rocky Branch pool (near Monticello), Grant Roberts farm. Dempsey Oil Co., Bradford, Pa., first oil from well.	M. W. Crouch	do	2	187	.9021	25.2	Black	Do.
410	Parmleysville pool (north end), James Burnett farm. Ross Wetzel & Co., Parmleysville.	M. J. Munn	do	3		.8348	37.7	Dark green	Do.
411	H. M. Caldwell, Monticello		do			.8211	40.5	do	
	Warren County.								
412	Sunnyside					.8426	36.2		

412. Pet. Rev., Oct. 27, 1906. Clifford Richardson.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	KENTUCKY—continued.															
	Wayne County—Continued.															
405	Johnson Fork field	53	13.5	0.7201	32.0	0.7980	49.9	0.9235	95.4	.....	3.01	2.66	.....	31.2	4.0	
406	.....	60	16.5	.7187	32.0	.7934	46.9	.9056	95.4	.....	4.57	0	.....	18.8	7.0	
407	Cooper pool, B. S. Huffaker farm, Penn Lubricating Co., Monticello.	35	25.0	.7155	29.0	.8062	42.1	.9186	96.1	.....	2.65	.80	.....	14.4	14.0	Beaver Creek sand.
408	Turkey Rock pool, Slickford district, Jos. Brown & Co., Slickford.	60	23.0	.7181	36.0	.7947	40.2	.9038	99.2	.....	2.31	.36	.....	15.6	14.0	
409	Rocky Branch pool (near Monticello), Grant Roberts farm, Dempsey Oil Co., Bradford, Pa., first oil from well.	170	.....	.....	26.0	.8183	73.0	.9259	99.0	.....	5.49	.....	Tr.	63.0	3.0	
410	Parmleysville pool (north end), James Burnett farm, Ross Wetzel & Co., Parmleysville.	76	13.0	.7174	36.0	.7959	47.9	.9115	96.9	.....	5.09	.....	Tr.	2.0	5.0	Do.
411	H. M. Caldwell, Monticello	67	16.0	.7148	37.5	.9979	41.2	.9150	94.7	.....	4.93	.41	.....	.....	.....	
	Warren County.															
412	Sunnyside	67	19.0	.....	37.0	.....	44.0	.....	100.0	.....	.....	.....	.....	.....	.....	Volatility in open dish, 150° C. (7 hours), 40.7 p. ct.; 160° C., 44.5 p. ct.; 200° C., 58 p. ct. To constant weight, 150° C. (42 hours), 70.6 p. ct.; 160° C. (7 hours), 73.8 p. ct.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baume.		
	LOUISIANA.								
	Caddo Parish.								
413	Hostetter farm, Mooringsport	G. D. Harris	Well			0.8187	41.0	Black	Like Okla. oil.
414	Caddo Oil and Mineral Co	do	do	Gilbert 1		.8264	39.4	do	Do.
415	Frank Filer Lease, NW. ¼ SE. ¼ sec. 7, T. 15, R. 20	do	Tank	1	2,250	.9211	22.0	do	Do.
416	Old Caddo Oil and Gas Co., E. K. Smith's land	do	Well	1	1,620	.8723	30.5	do	Do.
417	NW. ¼ NW. ¼ sec. 7, T. 15, R. 20	do	do	Richardson 2	2,245	.8929	26.8	do	Do.
418	Black Bayou Oil Co., SW. ¼ sec. 10, T. 15, R. 20	do	do	1	2,220	.9150	23.0	do	Do.
419	1 mile southeast of Vivian, NW. ¼ NE. ¼ sec. 36, T. 22 N, R. 16 W.	do	do	Dawes 1	1,050	.9253	21.3	do	Do.
420	Caddo Oil and Gas Co., E. K. Smith's farm	do	do	4	2,260	.9211	22.0	Brown	Do.
421	Caddo Oil and Gas Co., E. K. Smith's farm, SE. ¼ SW. ¼ sec. 1, T. 16, R. 20.	do	do	5		.8889	27.5	Black	Do.
422	Richardson Oil Co., NE. ¼ NW. ¼ sec. 32, T. 15 W., R. 21 N.	do	do	4	2,132	.9121	23.5	do	Do.
423	Brown Oil Co., Black Bayou	Brown Oil Co	do	1	+2,300	.9109	23.7	Brown	
424	James Bayou					.8065	43.6		

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude.	150°–300°C.	
	LOUISIANA.															
	Caddo Parish.															
413	Hostetter farm, Mooringsport.	138	3.0	.....	55.0	0.7778	40.4	0.8866	98.4	.....	1.70	0.09	.....	.....	.....	
414	Caddo Oil & Mineral Co.	136	1.5	.....	49.0	.7778	49.1	.8805	99.6	.....	5.30	.25	.....	.....	.....	
415	Frank Filer Lease, NW. ¼ SE. ¼ sec. 7, T. 15, R. 20.	200	.....	.....	12.0	.8510	82.9	.9061	94.9	.....	7.78	.91	.....	.....	.....	Contains water.
416	Old Caddo Oil & Gas Co., E. K. Smith's land.	210	.....	.....	28.0	.8299	69.5	.8895	97.5	.....	7.32	.14	.....	.....	.....	Do.
417	NW. ¼ NW. ¼ sec. 7, T. 15, R. 20.	173	.....	.....	20.0	.8408	79.0	.9061	99.0	.....	5.29	.50	.....	.....	.....	Do.
418	Black Bayou Oil Co., SW. ¼ sec. 10, T. 15, R. 20.	210	.....	.....	18.0	.8450	81.2	.9138	99.2	.....	.....	.24	.....	.....	.....	Do.
419	1 mile southeast of Vivian, NW. ¼ NE. ¼ sec. 36, T. 22 N., R. 16 W.	265	.....	.....	17.0	.8406	82.9	.9302	99.9	.....	.....	.22	.....	.....	.....	Do.
420	Caddo Oil & Gas Co., E. K. Smith's farm.	200	.....	.....	14.0	.8142	59.0	.8974	73.0	.....	3.64	.34	20	.....	.....	0.7 p. ct. clay.
421	Caddo Oil & Gas Co., E. K. Smith's farm, SE. ¼ SW. ¼ sec. 1, T. 16, R. 20.	220	.....	.....	18.0	.8406	79.4	.9003	97.4	.....	4.78	.64	.....	.....	.....	Much water.
422	Richardson Oil Co., NE. ¼ NW. ¼ sec. 32, T. 15 W., R. 21 N.	220	.....	.....	16.5	.8713	66.6	.9241	83.1	.....	.....	.54	.....	.....	.....	Do.
423	Brown Oil Co., Black Bayou.	248	.....	.....	10.5	.8690	88.2	.9235	98.7	.....	.....	.....	.....	.....	.....	
424	James Bayou	95	15.0	0.7275	47.0	.7770	40.0	.8739	102.0	0	7.02	.....	12.8	.....	.....	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	LOUISIANA—continued.								
	Calcasieu Parish.								
425	Jennings		Well	Heywood	1,000	0.9093	24.0		
426	Welsh			do	700	.9276	20.9		
427	Do					.9380	19.3	Olive green	
	Evangeline Parish.								
428	Sample No. 1		Tank			.8626	32.3		
429	Sample No. 2		Well			.8653	31.8		
	St. Martins Parish.								
430	Moresi Co., Anse Le Butte		Well	2	600	.9392	19.1		
431	Robt. Martin, Bayou Bouillion		do			.8590	33.0	Brownish black	
432	Do				900	.9669	14.8		
433	Bayou Laroupe		Well	Prospect well; not finished.	400	.9604	15.8		

425–426. Am. Chem. Soc. Jour., vol. 25, p. 1154. C. R. Coates and A. Best.
427. U. S. Geol. Survey Mineral Resources, 1905, p. 872, 1906. F. C. Thiele.
430. Am. Chem. Soc. Jour., vol. 25, p. 1154. C. R. Coates and A. Best.
431. U. S. Geol. Survey Bull. 282, 1906. Metz and Custiss, analysts.
432–433. Am. Chem. Soc. Jour., vol. 27, p. 1317. C. R. Coates and A. Best.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°-300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude.	150°-300° C.	
	LOUISIANA—continued.														
	Calcasieu Parish.														
425	Jennings	200	.....	.....	41.0	.....	59.0	.....	100.0	0.39	.....	5.0	.....	.....	.....	From 300°-350° C., 24 p. ct.; 350° C. to asphalt, 30 p. ct.; B. t. u., 19,814.
426	Welsh	230	.....	.....	19.0	.....	81.0	.....	100.0	.32	.....	9.0	.....	.....	.....	From 300°-350° C., 23 p. ct.; 350° C. to asphalt, 49 p. ct.; color of fraction, nearly colorless, light yellow on standing; B. t. u., 19,000.
427	Do	Over 91	1.05	0.831	30.07	0.952	68.88	.....	100.0	.0	.....	.....	.....	.....	.....	Lubricating oil, 65.38 p. ct.; coke and loss, 3.5 p. ct.; viscosity, 36.8 by Engler's method.
	Evangeline Parish.														
428	Sample No. 1	175	.....	.....	59.0	.8493	40.0	0.8980	99.0	.15	0	0	.....	6.8	.....	
429	Sample No. 2	173	.....	.....	59.0	.8493	41.0	.9009	100.0	.15	0	0	.....	8.8	.....	
	St. Martins Parish.														
430	Moresi Co., Anse Le Butte	240	.....	.....	16.0	.....	84.0	.....	100.0	.20	.....	9.0	.....	.....	.....	B. t. u. 19,300. When residue heated and evaporated in open dish it was hard, black, shiny, with conchoidal fractures; sp. gr., 1.123. Analysis residuum of asphalt showed volatile, 71 p. ct.; fixed carbon, 28.6 p. ct.; ash, 0.4 p. ct.
431	Robt. Martin, Bayou Bouillon.	.....	4.3	.....	28.4	.....	67.3	.....	100.0	.....	.....	.....	.....	.....	.....	Above 300° C., lubricating oil, 42 p. ct.; asphalt and coke, 15.5 p. ct.; loss, 9.8 p. ct.
432	Do	275	.....	.....	11.0	.....	89.0	.....	100.0	.57	.....	.....	.....	.....	.....	From 300°-350° C., 62 p. ct.; color of fraction, yellow; B. t. u., 18,500; residue, asphaltic.
433	Bayou Laroupe	265	.....	.....	6.0	.....	94.0	.....	100.0	Low	.....	.....	.....	.....	.....	From 300°-350° C., 7 p. ct.; color of fraction, yellow; residue, asphaltic.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	MICHIGAN.								
	Saginaw County.								
433c	Saginaw Development Co.	L. L. Linton	Well		2,340	0.8065	43.6	Light	Like Pa. oil.
	St. Clair County.								
434	Port Huron					.8333	38.0	Dark green	
	MISSOURI.								
	Cass County.								
435	Belton								
	NEW MEXICO.								
	Eddy County.								
436	Two miles east of Dayton, 10 miles southeast of Artesia; owned by W. S. Williams.	W. M. Dougherty.	Artesian well		1,000	.8951	26.4	Black	Sulphur.
437	Three miles south of Dayton; A. F. Lucas, Washington, D. C.	A. F. Lucas	Well		914	.9186	22.4	do	Do.
438	Dayton pool; Roswell Oil Co., Artesia	G. E. Morgan (manager Producers Oil Co.).	do	Hammond 1	914	.9168	22.7	do	Do.
439	Do	David T. Day	do	do	914	.9109	23.7	do	Do.

434. U. S. Geol. Survey Mineral Resources, 1905, p. 879, 1906.
435. U. S. Geol. Survey Mineral Resources, 1902, p. 566, 1904. Prof. Frankforter.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.					Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	MICHIGAN.															
	Saginaw County.															
433a	Saginaw Development Co...	98	15.0	0.7251	52.0	0.7854	33.4	0.8834	100.4	.....	0.78	0	0	.....	.....	
	St. Clair County.															
434	Port Huron.....	.....	15.0	.....	55.0	.....	30.0	.....	100.0	.....	.....	.....	.....	.....	.....	Lubricating oil, 20 p. ct.; tar, 5 p. ct.; coke, 5 p. ct. (Taken from card reporting production.)
	MISSOURI.															
	Cass County.															
435	Belton.....	.....	10.0	.....	19.0	.....	71.0	.....	100.0	.....	8.0	.....	.....	.....	.....	Lubricating oil, 53 p. ct.; residue tar, 10 p. ct.; with only a trace of organic matter.
	NEW MEXICO.															
	Eddy County.															
436	Two miles east of Dayton, 10 miles southeast of Artesia; owned by W. S. Williams.	217	.....	.....	30.0	.8395	68.9	.9241	98.9	(a)	.....	0.56	.....	(a)	(a)	a Not determined.
437	Three miles south of Dayton; A. F. Lucas, Washington, D. C.	137	Tr.	.....	28.5	.8564	68.4	.9444	96.9	(a)	0	0	.....	20.0	60.0	Do.
438	Dayton pool; Roswell Oil Co., Artesia.	188	.....	.....	28.0	.8541	72.0	.9396	100.0	(a)	0	3.65	.....	28.4	12.0	Do.
439	Do.....	142	1.0	.....	31.0	.8417	68.1	.9390	100.1	(a)	0	3.91	.....	25.6	14.0	Do.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	OHIO.								
	Allen County.								
440	Lima					0.7910	47.0	Dark Green	
441	Do					.8350	37.7	Dark brown, slightly fluorescent.	
442	Do					.8500	34.7	Dark brown	
443	Do					.8390	37.1		
	Fairfield County.								
444	Bremen pool, Rush Creek Township; L. Groves farm	J. A. Bownocker	Well		2,462	.7848	48.4	Medium green	Like Pa. oil.
445	Pleasantville pool, Richland Township; J. G. Ruff farm	do	do		+2,345	.8046	44.0	Dark green	Do.
	Hancock County.								
446	Findlay, Peerless Refining Co					.8390	37.1		
	Knox County.								
447	Bladenburg pool, Jackson Township	J. A. Bownocker	Well	McKee	2,771	.8469	35.3	Dark green	Like Pa. oil.

440. Am. Chem. Soc. Jour., vol. 13, p. 168. Mandell and Bourgougnon.
441. Am. Chem. Soc. Jour., vol. 13, p. 179. Durand Woodman.
442. Am. Chem. Soc. Jour., vol. 13, p. 180. Durand Woodman.
443. Franklin Inst. Jour., Nos. 834, 835. C. F. Mabery.
446. Am. Chem. Jour., vol. 17., p. 714. Charles F. Mabery.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.					Crude	150°–300° C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	OHIO.															
	Allen County.															
440	Lima	23	16.0	0.700	68.0	0.788	16.0	.....	100.0	.....	.....	.....	.....	.....	.....	Paraffin oil 6 p. ct.; sp. gr., 0.813.
441	Do	.....	10.0	Under .730	50.0	.....	40.0	.....	100.0	.....	.....	.....	.....	.....	.....	Lubricating oil, 30 p. ct.; sp. gr., 0.830.
442	Do	.....	.....	.....	.....	.....	.....	.....	.....	0.655	.....	.....	0.7	.....	.....	Gives naphtha and burning oil 56.8 p. ct.; heavy oil (above 500° F.), 32 p. ct.; residuum, 9.6 p. ct.
443	Do	.....	9.75	.7282	37.13	.7871	53.12	.....	100.0	.37	.....	.....	.....	.....	.....	300°–350° C., 8.63 p. ct.; sp. gr., 0.8242; bromine absorption, 6.1 p. ct.
	Fairfield County.															
444	Bremen pool, Rush Creek Township; L. Groves farm.	68	15.0	.7036	40.0	.7698	42.0	0.8557	97.0	.....	8.33	0	None.	11.6	4.0	Clinton sand.
445	Pleasantville pool, Richland Township; J. G. Ruff farm.	96	10.0	.7195	43.0	.7751	45.8	.8647	98.8	.....	5.36	0	None.	10.0	4.0	Do.
	Hancock County.															
446	Findlay, Peerless Refining Co.	.....	9.75	.7282	37.13	.7871	52.13	.....	99.01	.....	.....	.....	.....	.....	.....	Bromine absorption of distillate, 110°–150° C., 0.73 p. ct.; 150°–220° C., 1.74 p. ct.; 220°–257° C., 4.84 p. ct.; 257°–300° C., 5.04 p. ct.; 300°–330° C., 12.10 p. ct.; residuum, 19.50 p. ct.
	Knox County.															
447	Bladenburg pool; Jackson Township.	75	14.0	.7201	26.0	.7973	56.3	.9063	96.3	.....	4.17	0	Much	19.6	7.0	Clinton sand.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	OHIO—continued.								
	Monroe County.								
448	Decker pool (near Lewisville), Summit Township, sec. 23; Minard Run Oil Co., Bradford, Pa.; C. B. Buchanan lease.	M. W. Crouch	Well	1	1,500	0.7955	46.0	Light green	Like Pa. oil.
449	Decker pool (near Lewisville), Summit Township, sec. 23; Henry Dillar farm; W. G. Decker, Washington, Pa.	do	do	4	1,400	.7982	45.4	Dark amber	Do.
450	Near (250 feet) Ohio No. 5; Henry Dillar farm; W. G. Decker, Washington, Pa.	do	do	2	1,480	.7977	45.5	Medium green	Do.
451	Jerusalem pool, Malaga Township; Unity Oil Co., Woodsfield; Ernest Harper lease.	do	do	1		.8373	37.2	Dark amber	Do.
452	Jerusalem pool, Sunsbury Township; W. R. Gatchell lease; Central Gas Co., Woodsfield.	do	do	1	1,200	.7848	48.4	Medium amber	Do.
453	Clarington pool, Salem Township; Sterling farm, 2 miles north of Clarington; Consolidated Oil & Gas Co., Pittsburgh, Pa,	do	do	4	1,504	.7968	45.7	do	Do.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	OHIO—continued.															
	Monroe County.															
448	Decker pool (near Lewisville), Summit Township, sec. 23; Minard Run Oil Co., Bradford, Pa.; C. B. Buchanan lease.	77	18.0	0.7175	38.0	0.7787	42.4	0.8653	98.4	.....	2.82	0	Much	3.2	3.0	Big Injun sand.
449	Decker pool (near Lewisville), Summit Township, sec. 23; Henry Dillar farm; W. G. Decker, Washington, Pa.	87	16.0	.7225	39.0	.7758	44.9	.8563	99.9	.....	5.47	0	Much	2.8	3.0	Keener sand.
450	Near (250 feet) Ohio No. 5; Henry Dillar farm; W. G. Decker, Washington, Pa.	97	11.0	.8255	43.0	.7896	44.1	.8531	98.1	.....	2.23	0	Much	.....	8.0	Big Injun sand.
451	Jerusalem pool, Malaga Township; Unity Oil Co., Woodsfield; Ernest Harper lease.	100	5.0	.7815	30.0	.8195	63.6	.8589	98.6	.....	5.65	.....	Tr.	24.0	5.0	Keener sand.
452	Jerusalem pool, Sunsbury Township; W. R. Gatchell lease; Central Gas Co., Woodsfield.	55	19.0	.6837	35.5	.7696	43.1	.8568	97.6	.....	3.60	0	.....	6.8	4.0	Lime sand.
453	Clarington pool, Salem Township; Sterling farm, 2 miles north of Clarington; Consolidated Oil & Gas Co., Pittsburgh, Pa.	90	15.0	.7210	40.0	.7771	43.7	.8578	98.7	.....	5.65	0	.....	4.0	4.0	Lime and Keener sands.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	OHIO—continued.								
	Monroe County—Continued.								
454	Graysville pool, Washington Township; Scarbraugh farm; Pure Oil Co., Woodsfield.	M. W. Crouch	Well	4		0.7782	49.9	Amber	Like Pa. oil.
455	Olive Township; C. W. Brown farm	C. W. Brown, for M. J. Munn.	do	1		.8260	39.5	Dark amber	Do.
456	Griffith pool, Center Township; Markle heirs farm; Pure Oil Co., Woodsfield.	M. W. Crouch	do	2		.7937	46.4	Light amber	Do.
457	Bethel Township, sec. 7; Weber farm; Carter Oil Co., Sisterville, W. Va.	do	do			.7739	50.9	Dark amber	Do.
	Morgan County.								
458	Milner pool; J. W. Calvert farm	do	do	1	325	.8046	44.0	Dark green	Do.
459	Milner pool; Milner farm	do	do			.8023	44.5	do	Do.
	Noble County.								
460	Macksburg field, Jefferson Township; Geo. Rue farm	do	do	3	516	.8154	41.7	do	Do.
461	Do	do	do	2	1,470	.8159	41.6	do	Do.
462	Belle Valley pool, Noble Township; Harry Barnhouse lease; Chris McKee, Belle Valley.	do	do	7	1,465	.8240	39.9	do	Do.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°-300° C.		Residuum.		Total.					Crude	150°-300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	OHIO—continued.															
	Monroe County—Continued.															
454	Graysville pool, Washington Township; Scarbraugh farm; Pure Oil Co., Woodsfield.	70	25.0	0.7020	38.0	0.7715	36.7	0.8526	99.7	.....	3.35	0	.....	6.0	2.0	Keener sand.
455	Olive Township; C. W. Brown farm.	67	12.0	.7290	33.0	.7934	53.5	.8663	98.5	.....	11.24	0	.....	22.8	5.0	
456	Griffith pool, Center Township; Markle heirs farm; Pure Oil Co., Woodsfield.	75	18.5	.7232	42.0	.7903	39.3	.8537	99.8	.....	3.56	0	.....	5.6	5.0	Do.
457	Bethel Township, sec. 7; Weber farm; Carter Oil Co., Sisterville, W. Va.	65	19.0	.7034	51.0	.7721	28.5	.8521	98.5	.....	2.91	0	.....	4.8	5.0	Firs Cow Run sand.
	Morgan County.															
458	Milner pool; J. W. Calvert farm.	74	14.5	.7137	38.5	.7815	43.6	.8669	96.6	.....	5.36	0	.....	11.6	5.0	Do.
459	Milner pool; Milner farm....	70	19.0	.7141	37.0	.7834	43.2	.8623	99.2	.....	5.74	0	.....	4.4	5.0	Peaker sand.
	Noble County.															
460	Macksburg field, Jefferson Township; Geo. R. Rue farm.	115	5.0	.7435	43.0	.7901	50.0	.8626	98.0	.....	6.15	0	.....	3.6	3.0	Macksburg 500-foot sand.
461	Do.....	62	15.0	.7215	30.0	.7908	51.3	.8783	96.3	.....	4.86	0	.....	6.0	2.0	Berea sand.
462	Belle Valley pool, Noble Township; Harry Barnhouse lease; Chris McKee, Belle Valley.	57	13.0	.7250	28.0	.7463	55.8	.8805	96.8	.....	5.44	0	.....	3.2	4.0	Keener sand.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	OHIO—continued.								
	Noble County—Continued.								
463	.....	.....	.....	.....	.....	0.8293	38.8	.....	
	Perry County.								
464	San Toy pool, Bearfield Township; McCarty farm; Chapman lease.	M. W. Crouch.....	Well.....	3.....	1,260	.8240	39.9	Dark green	Like Pa. oil.
465	Crooksville pool, Harrison Township; Ohio Fuel Co. lot	J. A. Bownocker..	.....do.....	.....	3,407	.8014	44.7	Light amber.....	Do.
466	New Straitsville pool, Coal Township; Clancy lot.....	.....do.....	.....do.....	.....	3,106	.7923	46.7	(†).....	Do.
	Vinton County.								
467	Jackson Township; Clinton farm.....	J. A. Bownocker..	Well	.....	2,480	.7959	45.9	Medium green.....	Do.
	Washington County.								
468	Macksburg, Moseley farm.....	.....	.....	9.....	From 140-foot sand.	.8118	42.5	Light amber.....	

463. Soc. Chem. Indust. Jour., No. 20. Clifford Richardson. U. S. Geol. Survey Bull. 282, 1906.
468. Am. Chem. Jour., vol. 18, p. 218. Charles F. Mabery and Orton C. Dunn.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300° C.	
	OHIO—continued.														
	Noble County—Continued.														
463	.....	85	23.0	0.7297	21.0	0.8014	.....	.....	.....	0.6	.....	.....	.....	5.0	.....	Crude oil, carbon, 85 p. ct.; hydrogen, 13.80 p. ct.; oxygen and nitrogen, 0.60 p. ct. Distillate, 300°–350° C., 21 p. ct.; sp. gr., 0.8404; refractive index, 1.468; 350°–400° C., 27 p. ct.; sp. gr., 0.8643; refractive index, 1.481. Viscosity by P. R. R. pipette 42.
	Perry County.															
464	San Toy pool, Bearfield Township; McCarty farm; Chapman lease.	60	18.0	.7230	27.0	.7981	52.2	0.8917	97.2	.....	6.16	0	Tr.	8.0	5.0	Berea sand.
465	Crooksville pool, Harrison Township; Ohio Fuel Co. lot.	98	7.0	.7215	45.0	.7736	45.6	.8663	97.6	.....	6.63	0	.....	10.0	4.0	Clinton sand.
466	New Straitsville pool, Coal Township; Clancy lot.	80	17.5	.7141	33.0	.7753	45.7	.8706	96.2	.....	8.30	0	.....	10.8	6.0	Do.
	Vinton County.															
467	Jackson Township, Clinton farm.	102	4.0	.7140	51.0	.7673	43.6	.8600	98.0	.....	5.62	0	0	5.6	4.0	Do.
	Washington County.															
468	Macksburg, Moseley farm...	.....	[a]15.47	.....	[b]45.81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Crude oil, carbon, 85 p. ct.; hydrogen, 13.77 p. ct.; nitrogen, 0.027 p. ct.; bromine absorption, 7.62 p. ct. [a] Up to 160° C.; [b] 160°–310° C.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	OHIO—continued.								
	Washington County—Continued.								
469	Macksburg, Warren farm			1	From 1,500-foot sand.	0.8274	39.2	Amber	
470	Macksburg, J. S. Dunn farm			6	From 500-foot sand.	.7971	45.7	do	
471	Macksburg, McLauth farm				From 300-foot sand.	.8205	40.6	Peculiar reddish tinge.	
472	Macksburg, Moseley farm		Well	1	From 700-foot sand.	.8138	42.0	Amber	
473	Archers Fork, Ward farm		do	1	Berea grit oil.	.7939	46.4	Light amber	Like Pa. oil.
474	Germantown pool, Liberty Township; Hendershot lease, Consolidated Oil & Mining Co., Saltpeter.	M. W. Crouch	do	1	827	.8023	44.5	Medium green	Do.
475	Fifteen pool, Liberty Township	do	do		1,260	.7865	48.0	Dark amber	Do.

469. Am. Chem. Jour., vol. 18, p. 221. Charles F. Mabery and Orton C. Dunn.
470–471. Am. Chem. Jour., vol. 18, p. 219. Charles F. Mabery and Orton C. Dunn.
472. Am. Chem. Jour., vol. 18, p. 220. Charles F. Mabery and Orton C. Dunn.
473. Am. Chem. Jour., vol. 18, p. 225. Charles F. Mabery and Orton C. Dunn.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300° C.	
	OHIO—continued.															
	Washington County—Contd.															
469	Macksburg, Warren farm	.....	[a]10.64	.....	[b]29.17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Crude oil, carbon, 85.42 p. ct.; hydrogen, 14.59 p. ct.; nitrogen, 0.064 p. ct.; bromine absorption, 9.96 p. ct. [a] Up to 160° C.; [b] 160°–310° C.
470	Macksburg, J. S. Dunn farm	.....	[a]20.32	.....	[b]31.32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Crude oil, carbon, 84.19 p. ct.; hydrogen, 14.75 p. ct.; nitrogen, 0.015 p. ct.; bromine absorption, 9.46 p. ct. [a] Up to 160° C.; [b] 160°–310° C.
471	Macksburg, McLauth farm	.....	[a]14.12	.....	[b]33.27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Crude oil, carbon, 84.45 p. ct.; hydrogen, 13.79 p. ct.; nitrogen, 0.018 p. ct.; bromine absorption, 8.45 p. ct. [a] Up to 160° C.; [b] 160°–310° C.
472	Macksburg, Moseley farm	.....	[a]20.69	.....	[b]33.08	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Crude oil, carbon, 84.56 p. ct.; hydrogen, 14.33 p. ct.; nitrogen, 0.038 p. ct.; bromine absorption, 5.93 p. ct. [a] Up to 160° C.; [b] 160°–310° C.
473	Archers Fork, Ward farm	.....	[a]29.65	.....	[b]35.32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Crude oil, carbon, 84.35 p. ct.; hydrogen, 14.72 p. ct.; nitrogen, 0.038 p. ct.; bromine absorption, 6.25 p. ct. [a] Up to 160° C.; [b] 160°–310° C.
474	Germantown pool, Liberty Township; Hendershot lease, Consolidated Oil & Mining Co., saltpeter.	65	16.0	.7175	35.0	0.7797	45.4	0.8679	96.4	.....	6.43	0	.....	6.0	2.0	First Cow Run sand.
475	Fifteen pool, Liberty Township.	60	20.0	.6970	37.0	.7716	42.1	.8537	99.1	.....	7.25	0	.....	12.4	2.0	Maxton sand.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	OKLAHOMA.								
	Creek County.								
	Bird Creek and Skiatook pools:								
476	Prairie Oil & Gas Co., Tulsa, Bird Creek district	J. P. Dunlop	Pipe line			0.8626	32.3	Dark green	
477	N. Chisholm lease, Creek & Indiana Investment Co., Sperry.	do	Well	1	1,420	.8495	34.8	do	
478	Do	do	do	4	1,200	.8563	33.5	do	
	Skiatook pool:								
479	Smith lease, Shawnee Oil Co., Sperry	do	do	1	1,408	.8480	35.1	do	
480	Do	do	do	4	1,412	.8439	35.9	do	
481	Chisholm lease, Shawnee Oil Co., Sperry	do	do	2	1,466	.8328	38.1	do	
	Glenn pool:								
482	Grace Berryhill lease, Oklahoma State Oil Co., Kiefer.	do	do	9-13	1,500	.8459	35.5	Black	
483	Pittman farm, sec. 7, T. 17 N., R. 12, Argue & Compton, Tulsa.	do	do	11	1,500	.8459	35.5	do	
484	Pump station, Prairie Oil & Gas Co., Kiefer	do	Pipe line			.8464	35.4	do	
485	Thos. Berryhill lease, Indiana Oil & Gas Co., Kiefer.	do	Well	7	1,518	.8439	35.9	do	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°-300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°-300°C.	
	OKLAHOMA.															
	Creek County.															
	Bird Creek and Skiatook pools:															
476	Prairie Oil & Gas Co., Tulsa, Bird Creek district.	120	2.0	.....	37.5	0.8070	60.6	0.9003	100.1	.....	7.30	0.28	.....	29.2	6	
477	N. Chisholm lease, Creek & Indiana Investment Co., Sperry.	100	7.0	0.7380	38.5	.8018	52.8	.9021	98.3	.....	2.87	.62	.....	29.2	9	
478	Do	122	Tr.	.....	40.5	.8030	57.0	.9021	97.5	.....	8.41	.42	.....	14.0	11	
	Skiatook pool:															
479	Smith lease, Shawnee Oil Co., Sperry.	95	6.0	.7348	37.0	.7898	54.9	.9032	97.9	.....	7.35	.23	.....	14.8	7	
480	Do	98	5.0	.7440	36.0	.7858	58.8	.8997	99.8	.....	9.74	.50	.....	12.8	10	
481	Chisholm lease, Shawnee Oil Co., Sperry.	68	11.0	.7142	33.5	.7968	51.8	.8974	96.3	.....	6.65	.14	.....	13.2	10	
	Glenn pool:															
482	Grace Berryhill lease, Oklahoma State Oil Co., Kiefer.	112	7.5	.7464	42.0	.7980	50.0	.9061	99.5	.....	5.41	.11	.....	21.2	6	
483	Pittman farm, sec. 7, T. 17 N., R. 12, Argue & Compton, Tulsa.	105	8.5	.7566	42.0	.8001	49.9	.9032	100.4	.....	6.98	.45	.....	22.8	7	
484	Pump station, Prairie Oil & Gas Co., Kiefer.	100	4.5	.....	46.0	.7942	49.9	.9032	100.4	.....	5.99	.24	.....	27.6	9	
485	Thos. Berryhill lease, Indiana Oil & Gas Co., Kiefer.	105	8.0	.7508	44.5	.8008	48.0	.9091	100.5	.....	7.53	.90	.....	20.8	6	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	OKLAHOMA—continued.								
	Creek County—Continued.								
	Glenn pool—Continued.								
486	Wm. Berryhill lease, Indiana Oil & Gas Co., Kiefer.	J. P. Dunlop.....	Well.....	15.....	1,529	0.8333	38.0	Black.....	
487	W. B. Self lease, Prairie Oil & Gas Co., Tulsa.....	.....do.....	.....do.....	23.....	1,523	.8373	37.2	.....do.....	
488	Do.....	.....do.....	.....do.....	7.....	1,553	.8424	36.2	.....do.....	
	Mounds pool:								
489	Corndoffer lease, sec. 18, T. 16, R. 12, Swasey Oil Co., Fort Worth, Tex.	.....do.....	.....do.....	1.....	2,340	.8631	32.2	Bright green.....	
	Kiowa County.								
	Gotebo pool:								
490	Ricketts lease, Whitewater Oil & Gas Co., Gotebo.	J. P. Dunlop.....	Well.....	2.....	365	.8490	35.1	Black.....	
491	Seney lease, Deering Oil & Gas Co., Gotebo.....	.....do.....	Tank.....	2.....	443	.8552	33.7	.....do.....	
	Marshall County.								
492	Mal-Millan Oil Co., Madill, sec. 5, T. 5. S., R. 5 E.....	W. J. Reed.....	Well.....	6.....	420	.7887	47.5	Light green.....	

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Analyses of petroleum from various parts of the United States—Continued.

	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	OKLAHOMA—continued.															
	Creek County—Continued.															
	Glenn pool—Continued.															
486	Wm. Berryhill lease, Indiana Oil & Gas Co., Kiefer.	80	11.5	0.7260	43.5	0.7964	45.3	0.9079	100.3	.....	11.46	0.35	.....	21.6	4	
487	W. B. Self lease, Prairie Oil & Gas Co., Tulsa.	94	10.0	.7328	41.0	.7968	47.6	.9021	98.6	.....	3.12	.21	.....	16.8	5	
488	Do.....	98	10.0	.7402	42.5	.7990	47.6	.9079	100.1	.....	9.70	.51	.....	26.4	6	
	Mounds pool:															
489	Corndoffer lease, sec. 18, T. 16, R. 12, Swasey Oil Co., Fort Worth, Tex.	175	.....	.....	38.5	.8126	59.9	.8992	98.4	.....	8.44	.62	.....	12.4	4	
	Kiowa County.															
	Gotebo pool:															
490	Ricketts lease, Whitewater Oil & Gas Co., Gotebo.	115	3.5	.7399	45.5	.7828	51.5	.9097	100.5	.....	5.56	1.30	.....	29.6	15	
491	Seney lease, Deering Oil & Gas Co., Gotebo.	128	2.0	.....	40.0	.7884	56.9	.9186	98.9	.....	5.01	.31	.....	57.2	3	
	Marshall County.															
492	Mal-Millan Oil Co., Madill, sec. 5, T. 5 S., R. 5 E.	65	22.0	.7118	38.0	.7788	36.8	.8669	96.8	.....	7.41	.00	.....	.....	.....	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	OKLAHOMA—continued.								
	Muskogee County.								
	Muskogee pool, new field:								
493	Evans lease, Julia Oil Co., Muskogee	J. P. Dunlop	Well	1	1,553	0.8328	38.1	Green	
494	Do	do	do	3	1,473	.8264	39.4	do	
495	E. Stevens lease, Success Oil and Gas Co., Muskogee.	do	do	2	1,558	.8314	38.4	do	
496	J. W. Siebold lease, Success Oil and Gas Co., Muskogee.	do	do	1	1,574	.8343	37.8	do	
497	Fort Worth Development Co. lease, of Richmond Development Co., Muskogee.	do	do	1	1,702	.8333	38.0	do	
498	G. W. Sadler lease, Huckleberry & Co., Muskogee	do	do	3	1,735	.8348	37.7	do	
499	Prairie Oil and Gas Co., Muskogee	do	Pipe-line tank			.8358	37.5	Olive green	
	Muskogee pool, old field:								
500	Pioneer Oil and Gas Co., Muskogee	do	Well	1, 2, 3	1,000	.8216	40.4	Light olive green	
501	P. Connolly, Muskogee	do	do	Connelly	1,000	.8279	39.1	do	
502	Do	do	do	Reeves	1,000	.8328	38.1	do	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.					Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	OKLAHOMA—continued.															
	Muskogee County.															
	Muskogee pool, new field:															
493	Evans lease, Julia Oil Co., Muskogee.	97	11.0	0.7332	36.0	0.7960	52.8	0.8866	99.8	.....	7.64	0.0	.....	15.2	4	
494	Do	83	11.0	.7218	36.0	.7976	51.4	.8855	98.4	.....	6.03	.0	.....	16.8	5	
495	K. Stevens lease, Success Oil and Gas Co., Muskogee.	93	12.0	.7298	38.0	.7984	50.3	.8861	100.3	.....	2.24	.0	.....	15.2	3	
496	J. W. Siebold lease, Success Oil and Gas Co., Muskogee.	90	7.0	.7316	40.0	.7876	52.4	.8861	99.4	.....	1.24	.0	.....	16.8	2	
497	Fort Worth Development Co. lease, of Richmond Development Co., Muskogee.	90	11.0	.7090	37.0	.7986	51.2	.8861	99.2	.....	1.52	.0	.....	16.4	8	
498	G. W. Sadler lease, Huckleberry & Co., Muskogee.	98	5.0	.7410	40.0	.7828	54.6	.8855	99.6	.....	6.96	.0	.....	16.0	4	
499	Prairie Oil and Gas Co., Muskogee.	99	3.5	.7415	41.0	.7816	55.5	.8838	100.0	.....	12.45	.0	.....	17.6	2	
	Muskogee pool, old field:															
500	Pioneer Oil and Gas Co., Muskogee.	110	5.5	.7415	46.0	.7812	43.7	.8745	95.2	.....	3.88	.0	.....	12.0	4	
501	P. Connolly, Muskogee	115	4.0	.7520	48.0	.7856	48.4	.8750	100.4	.....	2.15	.0	.....	11.2	2	
502	Do	140	Tr.	.....	46.0	.7810	53.2	.8745	99.2	.....	4.91	.0	.....	12.4	2	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Physical properties.				
					Depth of well (feet).	Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	OKLAHOMA—continued.								
	Nowata County.								
	Childers pool:								
503	Sec. 35, T. 27, R. 16, Susan Connor lease, New York and Pennsylvania Oil Co., Nowata.	J. P. Dunlop	Well	1	735	0.8449	35.7	Dark green	
504	Sec. 8, T. 26, R. 16, Jane Clagett lease, F. D. Bailey, Nowata.	do	do	3	750	.8439	35.9	do	
	Delaware pool:								
505	Sec. 31, T. 27, R. 16, Wolf lease, Davis & Berrian, Nowata.	do	do	1	812	.8493	34.8	Light green	
506	Sec. 33, T. 27, R. 16, Edgar Bean lease, Van Vleck & Graham Oil Co., Nowata.	do	do	4	830	.8424	36.2	Dark green	
	Delaware and Childers pools:								
507	Prairie Oil and Gas Co., Station 40, Nowata	do	Tank			.8500	34.7	Dark brown	
	Nowata and Rogers counties.								
	Shallow sand pool:								
508	Prairie Oil and Gas Co., Station 38, Nowata	J. P. Dunlop	Pipe line			.8537	34.0	Black	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.													
			To 150° C.		150°-300° C		Residuum.		Total.					Crude	150°-300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	OKLAHOMA—continued.															
	Nowata County.															
	Childers pool:															
503	Sec. 35, T. 27, R. 16, Susan Connor lease, New York and Pennsylvania Oil Co., Nowata.	80	14.0	0.7415	33.0	0.8035	51.2	0.9090	98.2	.....	4.51	0.75	.....	38.4	10	
504	Sec. 8, T. 26, R. 16, Jane Claggett lease, F. D. Bailey, Nowata.	78	11.0	.7270	36.0	.8024	51.1	.9091	98.1	.....	4.59	.93	.....	22.0	7.5	
	Delaware pool:															
505	Sec. 31, T. 27, R. 16, Wolf lease, Davis & Berrian, Nowata.	65	16.5	.7435	35.0	.8195	47.4	.9156	98.9	.....	4.18	1.69	.....	18.4	8	
506	Sec. 33, T. 27, R. 16, Edgar Bean lease, Van Vleck & Graham Oil Co., Nowata.	81	9.0	.7182	38.5	.7966	51.6	.9138	99.1	.....	8.23	1.74	.....	12.8	10	
	Delaware and Childers pools:															
507	Prairie Oil and Gas Co., Station 40, Nowata.	107	3.0	.....	42.0	.7918	49.8	.9103	94.8	.....	4.45	.26	.....	24.0	3	
	Nowata and Rogers counties.															
	Shallow sand pool:															
508	Prairie Oil and Gas Co., Station 38, Nowata.	100	7.0	.7380	39.0	.8034	53.8	.9103	99.8	.....	3.04	.12	.....	24.4	3	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	OKLAHOMA—continued.								
	Okmulgee County.								
	Morris pool:								
509	Prairie Oil and Gas Co., Morris	J. P. Dunlop	Settling tank			0.8459	35.5	Light green	
510	Meridian lease, Brown Oil and Gas Co., Morris	do	Well	1	1,600	.8383	37.0	Dark green	
511	Do	do	do	4	1,600	.8403	36.6	Green	
	Bald Hill pool:								
512	Buchanan lease, Burns & Caton, Morris	do	do	1	1,680	.8531	34.1	Dark green	
513	J. W. Buchanan lease, J. Harmon, Morris	do	do	1	1,703	.8578	33.2	do	
	Osage County.								
	Bartlesville pool:								
514	Prairie Oil and Gas Co., Bartlesville	J. P. Dunop	Pipe line			.8584	33.1	Dark green	
515	Lease 31, Colliver Consolidated Oil Co., Markham & Ball, Bartlesville.	do	Well	5	1,487	.8521	34.3	Black	
516	Do	do	do	6	1,480	.8505	34.6	do	
517	Lot 32, Illuminating Oil Co., Bartlesville	do	do	20	1,500	.8547	33.8	Dark green	
	Shallow sand pool:								
518	T. 26 N., Skelton-Moore Oil Co., Bartlesville	do	do	14	1,088	.8396	36.7	Black	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	OKLAHOMA—continued.														
	Okmulgee County.														
	Morris pool:														
509	Prairie Oil and Gas Co., Morris.	112	3.0	.....	34.0	0.7924	62.1	0.8866	99.1	.....	11.90	0	.....	10.0	1	
510	Meridian lease, Brown Oil and Gas Co., Morris.	82	10.0	0.7260	30.0	.7988	57.1	.8861	97.1	.....	9.46	0	.....	13.6	3	
511	Do	75	13.0	.7338	31.0	.8008	56.4	.8895	100.4	.....	6.75	0.10	.....	13.2	8	
	Bald Hill pool:														
512	Buchanan lease, Burns & Caton, Morris.	110	5.5	.7515	36.0	.8018	58.0	.9003	99.5	.....	3.43	.15	.....	20.0	8	
513	J. W. Buchanan lease, J. Harmon, Morris.	131	1.5	.....	35.5	.8096	62.4	.8992	99.4	.....	5.70	.76	.....	16.4	3	
	Osage County.														
	Bartlesville pool:														
514	Prairie Oil and Gas Co., Bartlesville.	130	3.0	.7625	39.0	.8116	58.7	.8980	100.7	.....	5.27	.18	.....	25.2	2	
515	Lease 31, Colliver Consolidated Oil Co., Markham & Ball, Bartlesville.	115	3.0	.....	43.5	.7818	54.0	.8992	100.5	.....	2.73	1.00	.....	20.4	9	
516	Do	105	3.5	.7499	42.0	.7808	51.5	.9044	97.0	.....	2.61	1.34	.....	30.8	12	
517	Lot 32, Illuminating Oil Co., Bartlesville.	113	3.5	.7574	44.0	.7868	52.4	.9009	99.9	.....	7.90	1.12	.....	21.0	0	
	Shallow sand pool:														
518	T. 26 N., Skelton-Moore Oil Co., Bartlesville.	76	11.5	.7101	35.0	.7869	51.9	.9050	98.4	.....	.....	1.26	.....	21.2	8	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	OKLAHOMA—continued.								
	Pawnee County.								
	Cleveland pool:								
519	Prairie Oil & Gas Co., Cleveland station	J. P. Dunlop	Tank			0.8485	35.0	Black	
520	Center east side W. ½ S. 20, T. 21, R. 8, Minnetonka Oil Co., Cleveland.	Robert Wood	Well	Jones 2	1,352	.8363	37.4		
521	Center SW. ¼ 17-21-18, Minnetonka Oil Co., Cleveland.	do	do	Alderson 6	1,706	.8408	36.5		
522	SW. SE. 18-21-8, Minnetonka Oil Co., Cleveland	do	do	Haviland 7	1,799	.8192	40.9		
523	NW. ¼ 20-21-8, Minnetonka Oil Co., Cleveland	do	do	Jones 26	2,047	.8192	40.9		
524	NW. cor. NE. ¼ 21-21-8, Minnetonka Oil Co., Cleveland.	do	do	R. Lucas 1	2,075	.8197	40.8		
525	SW., NW. 20-21-8, Minnetonka Oil Co., Cleveland.	do	do	Jones 10	2,235	.8226	40.2		
	Cleveland pool in city limits:								
526	Laterette lease, Test Oil Co., Cleveland	J. P. Dunlop	do	16		.8516	34.4	Dark green	
527	Do	do	do	17		.8542	33.9	do	
528	Do	do	do	15		.8516	34.4	do	
529	Ohio & Indiana Oil Co., Cleveland	do	do	8-9		.8516	34.4	do	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	OKLAHOMA—continued.															
	Pawnee County.															
	Cleveland pool:															
519	Prairie Oil & Gas Co., Cleveland station.	97	10.0	0.7428	37.5	0.8074	52.5	0.8980	100.0	.....	6.06	0.20	.....	34.8	5	
520	Center east side, W. ½ Sec. 20, T. 21, R. 8, Minnetonka Oil Co., Cleveland.	105	10.0	.741	38.5	.7923	51.1	.8963	99.6	.....	5.7	0	.....	.....	.....	Taylor sand.
521	Center SW. ¼ 17–21–18, Minnetonka Oil Co., Cleveland.	70	11.0	.7345	35.0	.8061	50.1	.8966	96.1	.....	4.5	0	.....	.....	.....	
522	SW., SE. 18–21–8, Minnetonka Oil Co., Cleveland.	78	6.0	.717	39.5	.778	50.5	.884	96.0	.....	4.2	0	.....	.....	.....	Oswego sand.
523	NW. ¼ 20–21–8, Minnetonka Oil Co., Cleveland.	80	9.0	.7145	45.0	.784	44.2	.896	98.2	.....	6.1	0	.....	.....	.....	Skinner sand.
524	NW. cor. NE. ¼ 21–21–8, Minnetonka Oil Co., Cleveland.	78	8.0	.721	43.0	.780	47.5	.896	98.5	.....	4.2	0	.....	.....	.....	Peru sand.
525	SW., NW. 20–21–8, Minnetonka Oil Co., Cleveland.	105	4.0	.7265	48.0	.774	47.8	.892	99.8	.....	7.6	0	.....	.....	.....	Bartlesville sand.
	Cleveland pool in city limits:															
526	Laterette lease, Test Oil Co., Cleveland.	100	9.5	.7794	35.0	.8166	55.4	.8980	99.9	.....	7.75	.03	.....	38.4	3	
527	Do	115	2.5	.7705	40.0	.8060	55.4	.8992	97.9	.....	6.63	.15	.....	35.2	2	
528	Do	103	7.0	.7586	36.0	.8124	56.4	.8980	99.4	.....	7.86	.81	.....	39.2	2	
529	Ohio & Indiana Oil Co., Cleveland.	117	4.5	.7670	39.0	.8060	55.9	.8980	99.4	.....	6.62	.30	.....	34.8	2	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	OKLAHOMA—continued.								
	Pawnee County—Continued.								
	Cleveland pool, Jordan Valley Township:								
530	Cory lease, F. M. Martin, Cleveland	J. P. Dunlop	Well	1	1,157	0.8464	35.4	Dark green	
531	L. L. Corey lease, J. E. Martin, Cleveland	do	do	1	1,174	.8403	36.6	do	
532	Berger lease, Prairie Oil & Gas Co., Independence, Kans.	do	do	7	1,800	.8388	36.9	do	
533	Do	do	do	4	1,750	.8605	32.7	do	
534	Lowery lease, Louisiana Purchase Oil Co., Cleveland.	do	do	2	1,620	.8459	35.5	do	
535	Do	do	do	6	1,600	.8669	31.5	do	
	Rogers County.								
	Alluwe pool:								
536	Sec. 16, T. 24, R. 17, Horace M. Adams, Chelsea	J. P. Dunlop	Well	12	400	.8413	36.4	Dark green	
537	Do	do	do	11	400	.8413	36.4	Greenish black	
	Chelsea pool:								
538	Sec. 16, T. 24, R. 16, Steuben lease, H. M. Adams, Chelsea.	do	do	38	500	.8511	34.5	do	
539	Sec. 14, T. 24, R 16, Bennett lease, H. M. Adams, Chelsea.	do	do	1	498	.8516	34.4	Dark brown	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.												
			To 150° C.		150°-300° C.		Residuum.		Total.							Crude	150°-300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.						
	OKLAHOMA—continued.														
	Pawnee County—Contd.														
	Cleveland pool, Jordan Valley Township:														
530	Cory lease, F. M. Martin, Cleveland.	110	5.0	0.7530	44.0	0.7992	48.8	0.8974	97.8	.....	5.55	0.05	.....	32.4	3
531	L. L. Cory lease, J. E. Martin, Cleveland.	108	7.5	.7398	44.5	.7882	48.0	.8974	100.0	.....	5.59	1.18	.....	33.2	5
532	Berger lease, Prairie Oil & Gas Co., Independence, Kans.	80	10.0	.7200	43.5	.7978	46.5	.9056	100.0	.....	5.42	1.12	.....	38.8	7
533	Do	120	1.0	.7603	41.0	.8030	56.9	.8969	98.9	.....	5.68	.92	.....	20.4	12
534	Lowery lease, Louisiana Purchase Oil Co., Cleveland.	85	15.5	.7452	36.0	.8119	48.5	.9082	100.0	.....	4.38	.82	.....	26.4	.....
535	Do	140	Tr.	.....	39.5	.8139	60.7	.9088	100.2	.....	7.26	.63	.....	25.2	4
	Rogers County.														
	Alluwe pool:														
536	Sec. 16, T. 24, R. 17, Horace M. Adams, Chelsea.	67	10.0	.7134	33.0	.7910	54.2	.9091	97.2	.....	6.14	0.55	.....	21.2	9
537	Do	65	15.0	.7245	32.0	.7995	50.1	.9168	97.1	.....	2.89	4.01	.....	23.2	9
	Chelsea pool:														
538	Sec. 16, T. 24, R. 16, Steuben lease, H. M. Adams, Chelsea.	80	13.5	.7148	31.0	.8035	54.8	.9168	99.3	.....	9.10	1.26	.....	26.0	8
539	Sec. 14, T. 24, R. 16, Bennett lease, H. M. Adams, Chelsea.	97	6.0	.7206	35.0	.7924	54.6	.9272	95.6	.....	4.16	2.19	.....	26.4	13

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	OKLAHOMA—continued.								
	Seminole County.								
	Wewoka pool:								
540	Wewoka Realty & Trust Co., Wewoka	J. P. Dunlop	Well	1	1,625	0.8844	28.3	Black	
	Tulsa County.								
	Red Fork pool:								
541	J. L. Yorgee lease, Robt. Galbreath, Tulsa	J. P. Dunlop	Well	3	638	.8368	37.3	Green	
542	Do	do	do	5	601	.8323	38.2	Dark green	
543	Van Yorgee lease, Robt. Galbreath, Tulsa	do	Leader pipe	1–7	1,240	.8413	36.4	do	
544	Missouri Lincoln Trust Co. lease, L. E. Mallory & Son, Tulsa.	do	Well	1	1,200	.8358	37.5	Black	
545	Pump station at Red Fork, Prairie Oil & Gas Co., Independence, Kans.	do	Pipe line			.8594	32.9	do	
	Washington County.								
	Bartlesville pool:								
546	Prairie Oil & Gas Co., Bartlesville	J. P. Dunlop	Pipe line			.8521	34.3	Dark green	
	Dewey and north of Dewey:								
547	T. 27, Williams lease, Stubbs & Lowe, Dewey	do	Well	4	1,200	.8605	32.7	do	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	OKLAHOMA—continued.														
	Seminole County.														
	Wewoka pool:														
540	Wewoka Realty & Trust Co., Wewoka.	128	1.5	.....	30.0	0.8266	67.3	0.9067	98.8	.....	6.28	0.90	.....	30.0	3	
	Tulsa County.														
	Red Fork pool:														
541	J. I. Yorgee lease, Robt. Galbreath, Tulsa.	88	15.0	0.7195	36.0	.7945	48.5	.9073	99.5	.....	2.60	0	.....	22.4	.....	
542	Do	93	9.0	.7220	40.5	.7814	48.5	.9038	98.0	.....	4.39	0	.....	17.6	1	
543	Van Yorgee lease, Robt. Galbreath, Tulsa.	90	14.0	.7352	37.0	.7992	48.9	.8855	99.9	.....	6.37	.05	.....	22.4	2	
544	Missouri Lincoln Trust Co. lease, L. E. Mallory & Son, Tulsa.	97	8.0	.7268	44.5	.7882	47.0	.9021	99.5	.....	3.92	.35	.....	14.4	3	
545	Pump station at Red Fork, Prairie Oil & Gas Co., Independence, Kans.	110	4.0	.7430	38.0	.7948	55.8	.9103	97.8	.....	4.88	.15	.....	18.4	1	
	Washington County.														
	Bartlesville pool:														
546	Prairie Oil & Gas Co., Bartlesville.	103	8.0	.7378	37.0	.8090	54.5	.9038	99.5	.....	3.75	.23	.....	24.4	4	
	Dewey and north of Dewey:														
547	T. 27, Williams lease, Stubbs & Lowe, Dewey.	103	3.0	.....	42.0	.8008	55.0	.9103	100.0	.....	6.07	.47	.....	18.8	1	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	OKLAHOMA—continued.								
	Washington County—Continued.								
	Dewey and north of Dewey—Continued.								
548	Berger lease, Woodward & Roll, Dewey	J. P. Dunlop	Well	1	525	0.8772	29.6	Black	
549	McEwen lease, Stubbs & Lowe, Dewey	do	do	5	500	.8605	32.7	do	
	Webber pool:								
550	Shaler lease, Bartles Oil Co., Dewey	do	do	7	1,250	.8368	37.3	Dark green	
551	Stubbs & Lowe, Dewey	do	do	2	1,200	.8485	35.0	do	
552	(R. C. A.) Adams Oil & Gas Co., Washington, D.C.	do	do	1	1,300	.8547	33.8	do	
	PENNSYLVANIA.								
553	(Not located)					.8175	41.3		
554	Do		Pipe line			.8014	44.7		
555	Do					a.8160	41.6		

553. Dinglers' Polytech. Jour., vol. 261, pp. 29–34. C. Engler and I. Levin.
554. Soc. Chem. Indust. Jour., No. 20, p. 691. Clifford Richardson and E. C. Wallace.
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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.												
			To 150° C.		150°-300° C.		Residuum.		Total.							Crude	150°-300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	centimeters.									
	OKLAHOMA—continued.														
	Washington County—Contd.														
	Dewey and north of Dewey—Continued.														
548	Berger lease, Woodward & Roll, Dewey.	128	1.0	0.8549	32.0	0.7972	63.3	0.9024	96.3	.....	3.50	1.43	.....	38.0	2	
549	McEwen lease, Stubbs & Lowe, Dewey.	80	9.5	.7299	28.0	.7968	58.5	.9241	96.0	.....	3.68	1.26	.....	34.8	.....	
	Webber pool:														
550	Shaler lease, Bartles Oil Co., Dewey.	70	13.0	.7214	33.0	.8008	51.9	.9067	97.9	.....	3.01	.94	.....	20.8	4	
551	Stubbs & Lowe, Dewey.	98	6.0	.7339	40.0	.7928	53.9	.9079	99.9	.....	6.81	.99	.....	20.5	11	
552	(R. C. A.) Adams Oil & Gas Co., Washington, D. C.	95	7.5	.7559	39.0	.8128	53.1	.8906	99.6	.....	2.26	.85	.....	30.8	14	
	PENNSYLVANIA.														
553	(Not located)	82	21.0	.....	38.25	.....	40.75	.....	100.0	.....	.....	.....	.....	.....	.....	
554	Do	80	21.0	.7188	41.0	.7984	37.00	.....	99.0	0.06	.....	.....	.....	.....	1.8	Viscosity by P. R. R. pipette 37. Crude oil, carbon, 86.10 p. ct.; hydrogen, 13.90 p. ct. 300°-350° C., 14 p. ct.; sp. gr., 0.8338; refractive index, 1.462.
555	Do	.....	[b]20.3	.....	[c]59.7	.....	.....	.....	100.0	.....	.....	.....	.....	.....	.....	[a] Sp. gr. at 0° C.; [b] up to 140° C.; [c] 140°-200° C. Composition of crude oil, carbon, 82 p. ct.; hydrogen, 14.8 p. ct.; oxygen, 3.2 p. ct. Heat of combustion, 9,963.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	PENNSYLVANIA—continued.								
556	(Not located)					a0.8861	28.0		
557	Do					.8160	41.6		
558	Perry County, Millerstown					.7901	47.2		
559	Venango County					.8822	28.7	Dark brown	
	TEXAS.								
	Bexar County.								
560	San Antonio			Walsh		.8800	29.1	Reddish brown	
561	Do			Dullnig		.9179	22.5	do	
	Hardin County.								
	Sour Lake pool:								
562	Township 75, Cannon tract, O. T. Taber, Sour Lake.	O. T. Taber	Well	3	1,310	.9067	24.4	Dark green	Sulphur.
563	Taber Oil Co., Sour Lake	David T. Day	do	a 1	1,780	.9272	21.0	Black	Do.
564	Rodger's tract, township 81, Taber Oil Co., Sour Lake.	O. T. Taber	do	1		.9421	18.6	do	Do.
565	Graham and Gore, Sour Lake	David T. Day	do	3	1,745	.9144	23.1	do	Do.
566	Sun Co., Beaumont	do	do	2	1,020	.9352	19.7	Dark green	Do.

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560. Texas Univ. Min. Survey Bull. 1, p. 51. O. H. Palm, analyst.
561. Texas Univ. Min. Survey Bull. 1, p. 51. S. H. Worrell.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	PENNSYLVANIA—continued.															
556	(Not located)				[b]12.0											[a] Sp. gr., 0° C.; [b] up to 280° C. Composition of crude oil, carbon, 84.9 p. ct.; hydrogen, 13.7 p. ct.; oxygen, 1.4 p. ct.
557	Do		19.7		44.77	0.792	35.52		99.99							(Article written by Clifford Richardson.)
558	Perry County, Millerstown		17.0	0.693	43.0	.765	40.0		100.0							Separated into 100 fractions; percentages, 17, 43, 40, are approximate; residuum, 10 p. ct.
559	Venango County		8.55		[a]42.78		[b]48.67		100.0							[a] 150°–270° C.; [b] includes loss and water.
	TEXAS.															
	Bexar County.															
560	San Antonio		4.73	.745	36.90	.8117	58.37		100.0	2.02						Residue, 10 p. ct.; loss, 0.30 p. ct.; fraction up to 250° C., colorless.
561	Do		1.10		[a]27.30		71.60		100.0	1.52						[a] 150°–275° C.; residue, 8.40 p. ct.; loss, 2.20 p. ct.
	Hardin County.															
	Sour Lake pool:															
562	Township 75, Cannon tract, O.T. Taber, Sour Lake.	95	3.0		31.0	.8597	65.9	0.9440	99.9		0	0	Tr.	31.2	11.0	Beatty sand.
563	Taber Oil Co., Sour Lake	185			20.0	.8721	79.4	.9409	99.4		0	.40	Tr.	46.0	9.0	
564	Rodger's tract, township 81, Taber Oil Co., Sour Lake.	187			19.0	.8761	80.4	.9472	99.4		0	.57	Tr.	36.4	9.0	
565	Graham and Gore, Sour Lake.	95	1.0		25.0	.8377	72.0	.9377	98.0		0	0	Tr.	31.2	11.0	
566	Sun Co., Beaumont	170			23.0	.8750	76.7	.9569	99.7		0	0		59.6	11.0	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	TEXAS—continued.								
	Hardin County—Continued.								
	Sour Lake pool—Continued.								
567	Minor Oil Co. (Caprock oil from Shoestring)	David T. Day	Well	23	1,100	0.9026	25.1	Black	Sulphur.
568	Sour Lake					.9630	15.4		
569	Do					.9494	17.5	Reddish brown	
570	Saratoga pool, Rio Bravo Oil Co., Houston	David T. Day	Well	220	994	.9472	17.8	Black	Do.
571	Do	do	do	265	1,377	.9217	21.9	do	Do.
572	Gulf coast oil					.9272	21.0		
573	Batson, United Oil & Refining Co., Beaumont		Refining sample			.8878	27.7		
	Harris County.								
	Humble pool:								
574	W. S. Farish, Houston (Caprock oil)	David T. Day	Well		1,174	.9198	22.2	Black	Do.
575	Patrick Bros., Humble; shallow well	do	do		900	.9340	19.9	Dark green	Do.
	Jack County.								
576						.9211	22.0	Blackish brown	

568. Am. Chem. Jour., vol. 22, p. 489. F. C. Thiele. Texas Univ. Min. Survey Bull. 1, p. 43.
569. Soc. Chem. Indust. Jour., No. 19, p. 122. Clifford Richardson.
573. U. S. Geol. Survey Bull. 282, 1906. N. M. Fenneman.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.								
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	TEXAS—continued.														
	Hardin County—Continued.														
	Sour Lake pool—Continued.														
567	Minor Oil Co. (Caprock oil from Shoestring).	96	2.0	.....	32.0	0.8401	65.4	0.9409	99.4	.....	0	0.55	.....	22.8	5.0	
568	Sour Lake	.....	[a]0.1	.....	21.08	.8282	78.82	.....	100.0	.....	.....	20.0	.....	.....	.....	[a] To 160° C.
569	Do	.....	6.6	[a]0.8693	[b]15.3	.8974	[c]78.1	.....	100.0	.....	.....	.....	.....	.....	.....	[a] At 20° C.; [b] 150°–175° C.; [c] reddish-brown maltha, very sticky. Refractive indices, [a] 1.474, [b] 1.489, [c] 1.500.
570	Saratoga pool, Rio Bravo Oil Co., Houston.	212	.....	.....	18.0	.8856	81.1	.9615	99.1	.....	0	.74	Tr.	66.8	9.0	
571	Do	175	.....	.....	28.0	.9661	72.0	.9504	100.0	.....	0	.59	Tr.	36.4	9.0	
572	Gulf coast oil	185	.....	.....	20.0	.8721	79.4	.9409	99.4	.....	0	.40	.....	46.0	.....	
573	Batson, United Oil & Refining Co., Beaumont.	.....	6.5	.....	20.4	.....	73.1	.....	100.0	.....	.....	6.0	.....	.....	.....	14.4 p. ct. solar oil, 46.7 p. ct. lubricating oil.
	Harris County.															
	Humble pool:															
574	W. S. Farish, Houston (Caprock oil).	118	.5	.....	40.0	.8646	58.3	.9615	98.8	.....	0	3.17	Tr.	26.4	5.0	
575	Patrick Bros., Humble; shallow well.	223	.....	.....	18.0	.8938	81.1	.9321	99.1	.....	0	.....	.....	62.4	3.0	
	Jack County.															
576	.....	137	.88	.....	17.53	.8399	81.59	.....	100.0	.....	.....	.....	.....	.....	.....	300° C. up, 68.99 p. ct.; asphalt and coke, 12.60 p. ct. Special precaution against cracking. Result of redistillation of distillate also given by which gasoline and illuminating oil product increased by cracking.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	TEXAS—continued.								
	Jefferson County.								
577	Beaumont					0.922	21.9		
578	Do					.920	22.2		
579	Do					.9115	23.6	Dark green	
580	Do					.9217	21.9		
581	Do		Well	Lucas	1,200	.9228	21.7		
582	Do			Forward Reduction Co.		.950	17.4		
583	Do					.925	21.4		
584	Do			Higgins Fuel and Oil Co.		.9103	23.8	Reddish brown	

577. U. S. Geol. Survey Mineral Resources, 1901, p. 571, 1902. Sir Boverton Redwood.
578. U. S. Geol. Survey Mineral Resources 1901, p. 571, 1902. J. E. Denton; (*a*) Richardson and Wallace.
579. Chem. Trade Jour., Mar. 2, 1901. Emery Manufacturing Co., Bradford, Pa.
580. U. S. Geol. Survey Bull. 282, 1906. United Oil & Refining Co., Beaumont.
581. Am. Chem. Soc. Jour., vol. 25, p. 1154. C. R. Coates and Alfred Best.
582. Am. Chem. Soc. Jour., vol. 22, p. 551. C. F. Mabery and D. M. Buck.
583. Texas Univ. Min. Survey Bull. 1, p. 76. Ledoux & Co., analysts.
584. Texas Univ. Min. Survey Bull. 1, p. 74. O. H. Palm, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	TEXAS—continued.															
	Jefferson County.															
577	Beaumont									1.33						Viscosity, Redwood standard (188 seconds), 33.3 at 15.5° C.; fluid at 0° F. Carbonaceous residue on distillation to dryness, 4.40 p. ct.; caloric value, B. t. u., 19,388.
578	Do	83								1.75				39.00		Carbon, 84.60 p. ct.; hydrogen, 10.90 p. ct.; oxygen and nitrogen, 2.87 p. ct. Cold test, 6°F.; calorific value, B. t.u., 19,060. Carbon, 85.03 p. ct.; hydrogen, 12.30 p. ct.
579	Do		3.12		12.5		84.38		100.0							No evidence of congealing at 5° F.; 4 gallons distilled gravity of first 10-pint samples of distillates, 38.9° B., 33.1° B., 32.6° B., 31.6° B., 30.8° B., 29.3° B., 28.6° B., 27.6° B., 26.7° B. Fuel oil, 78.12 p. ct.
580	Do		1.8		17.1		81.1		100.0			7.5				Solar oil, 15.4 p. ct.; lubricating oil, 52.2 p. ct.
581	Do	150			36.0		64.0		100.0	1.96		8.0				300°–350° C., 26 p. ct.; 350° to asphalt, 30 p. ct. Large quantities H_2S evolved 115°–150° C.; B. t. u., 19,923.
582	Do									.94						Distilled in vacuo under 13mm. pressure; up to 150° C., 10 p. ct.; sp. gr., 0.8753; 150°–230° C., 32 p. ct.; sp. gr., 0.9222; 230°–300° C., 21 p. ct.; sp. gr., 0.9602; above 300° C., 37p. ct. (very thick). Sulphur by Carius method.
583	Do		[a]6.0	0.851	[b]41.5		52.5	0.8798	100.0	2.04						[a] Up to 200° C.; [b] 200°–300° C.
584	Do		2.9	.7938	39.8		57.3	.8759	100.0	2.40						B. t. u., 19,785. Heavy oil, 42.6 p. ct.; sp. gr., 0.9078; residue, 7.6 p. ct.; loss, 7 p. ct. Distillates above 617° C., 36.8 p. ct.; sp. gr., 0.9084.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	TEXAS—continued.								
	Jefferson County—Continued.								
585	Beaumont					0.9121	23.5		
586	Do		Well	Lucas		.9206	22.1	Brown opaque	
587	Do		do	do		.9121	23.5		
588	Do		do	do	From 1,130-foot sand.	.9162	22.8		
589	Do		do	do	895–899	.9218	21.9		
590	Do		do	do		.9200	22.2		
	Spindletop pool:								
591	L. P. Hammond & Co., Chicago, Ill.	David T. Day	do	[b] 1	1,130	.9085	24.1	Dark green	Sulphur.
592	Wilson-Broach Co., Beaumont	do	do	[c] 3	815	.9126	23.4	do	Do.

585. Texas Univ. Min. Survey Bull. 1, p, 75. L. W. Wilkinson.
586. Franklin Inst. Jour., September, 1902. F. C. Thiele.
587. Soc. Chem. Indust. Jour., vol. 20, p. 691, 1900. Richardson and Wallace.
588, 589. Texas Univ. Min. Survey Bull. 1, p. 72. E. P. Shock, analyst.
590. Am. Chem. Soc. Jour., vol. 23, p. 264. C. F. Mabery.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	TEXAS—continued.														
	***Jefferson County*—Contd.**														
585	**Beaumont**				33.7										300°–360° C., 7.5 p. ct.
586	**Do**		6.45		35.0 36.0		58.55 64.0	0.872	100.0 100.0			6.34			Test of kerosene, color, prime white, flash point, 120° F.; light lubricating, 21.05 p. ct.; medium lubricating, 21.05 p. ct.; heavy lubricating, 10.52 p. ct.; loss, gas, and sulphur, 5.04 p. ct.
587	**Do**	110	2.5		40.0		57.5	.8749	100.0	1.75				39.0		Ultimate composition: Carbon, 85.03 p. ct.; hydrogen, 12.30 p. ct.; oxygen and nitrogen, 0.92 p. ct. Volatility in open dish (7 hours), 110° C., 19.19 p. ct.; 162° C., 31.31 p. ct.; 205° C., 57.57 p. ct.
588	**Do**		[a]1.78		[b]44.08		54.14		100.0							[a] To 160° C.; [b] 160°–360° C.; residue, 4.24 p. ct.; loss, 5.26 p. ct.
589	**Do**		[a]1.96		[b]53.77		44.27		100.0							[a] To 160° C.; [b] 160°–360° C.; residue, 3.33 p. ct.; loss, 3.86 p. ct.
590	**Do**									2.16						Distilled under atmospheric pressure, 145°–200° C., 4 p. ct.; 200°–250° C., 11 p. ct. Distilled uner 14 mm. pressure, 95°–100° C., 17 p. ct.; 150°–200° C., 17 p. ct.; 200°–250° C., 51 p. ct.; residue, 15 p. ct. Nitrogen more than 1 p. ct.
	Spindletop pool:														
591	**L. P. Hammond & Co., Chicago, Ill.**	135	.5		37.0	0.8611	62.3	.9396	99.8		0	0	Tr.	22.8	8.0	
592	**Wilson-Broach Co., Beaumont.**	153			33.5	.8699	65.7	.9434	99.2		0	0		25.2	6.0	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	TEXAS—continued.								
	Marion County.								
593	Caddo (La.) pool, J. M. Guffey Co., Beaumont	David T. Day	Well	Burr 1	±2,300	0.8065	43.6	Brown	Like Pa. oil.
	Medina County.								
594	Dunlay					.9031	25.0	Reddish brown	
	McLennan County.								
595	Waco					.8432	36.0		
	Navarro County.								
596	Corsicana								
597	Do					.8604	32.7	Dark brown	
598	Do					.8292	38.8	Very dark brown, opaque.	
599	Do					.8493	34.8	Dark reddish brown, green fluorescence.	
600	Do								
601	Powell pool, H. G. Johnston, Corsicana; Stout lease	H. G. Johnston	Well	7	815	.9121	23.5	Black	Aromatic.

594. Texas Univ. Min. Survey Bull. 1, p. 52. O. H. Palm, analyst.
595. Texas Univ. Min. Survey Bull. 1, p. 5. D. E. Everhart, analyst.
596. Texas Agr. Exper. Sta. Bull. 11; U. S. Geol. Survey Mineral Resources, 1897, p. 848, 1898.
597. Texas Univ. Min. Survey Bull. 1, p. 48. W. H. Harper, analyst.
598. Texas Univ. Min. Survey Bull. 1, p. 49. E. H. Ernshaw, analyst.
599. Soc. Chem. Indust. Jour., vol. 19, p. 121. Clifford Richardson.
600. Am. Chem. Jour., vol. 22, p. 489. F. C. Thiele, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	TEXAS—continued.															
	Marion County.															
593	Caddo (La.) pool, J. M. Guffey & Co., Beaumont.	100	6.0	0.7305	50.5	0.7646	42.9	0.8739	99.4	.....	7.02	.....	.....	12.8	5.0	
	Medina County.															
594	Dunlay	172	6.10	.7519	29.94	.8330	63.96	.....	100.0	2.09	.....	.....	.....	.....	.....	Residuum semisolid asphalt; 13.50 p. ct. of distillate colorless.
	McLennan County.															
595	Waco	.....	[a]1.39	.....	[b]40.03	.....	[c]58.58	.....	100.0	.....	.....	.....	.....	.....	.....	[a] Up to 205° C.; [b] between 205° C. and 271° C.; [c] principally paraffin and paraffin oil.
	Navarro County.															
596	Corsicana	80	[a]34.6	.....	[b]40.0	.....	25.4	.....	100.0	.....	.....	.....	.....	.....	.....	[a] Up to 140° C.; [b] 140°–305° C. Above 305° C., 15.8 p. ct.; coke residue, 9.6 p. ct.
597	Do	77	[a]24.78	.755	[b]59.94	.....	15.28	.....	100.0	.....	.....	.....	.....	.....	.....	[a] Portion of fraction 77–203° F. lost before measured; [b] 150°–280° C. Up to 150° distillate colorless.
598	Do	54.4	[a]15.5	.7090	[b]39.75	.7881	44.75	.....	100.0	.....	.....	.....	.....	.....	.....	[a] To 149° C.; [b] to 288° C. Distillate colorless up to 500° C.
599	Do	57	[a]28.0	.7819	[b]15.8	.8244	56.2	.....	100.0	.....	.....	.....	.....	.....	.....	[a] To 151° C.; [b] 151°–180° C., distilled at 25 mm. pressure. Volatile: 100° C., 10.8 p. ct. naphtha; 162° C., 35.7 p. ct. naphtha; 204° C., 11.2 p. ct. naphtha. Cracking begins 175° C.
600	Do	.....	10.8	.710	54.5	.796	34.7	.....	100.0	.....	.....	.....	.....	.....	.....	
601	Powell pool, H. G. Johnston, Corsicana; Stout lease.	168	.....	.....	19.5	.8571	80.1	.9296	99.6	.....	0	0	.....	31.6	5.0	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	TEXAS—continued.								
	Navarro County—Continued.								
602	Corsicana pool, Staley & Barnsdall, Corsicana	David T. Day	Well	13	{ 1,000 1,100	0.8500	34.7	Black	Aromatic.
	Pecos County.								
603	Fort Stockton					.9250	21.4	Very dark brown, opaque.	
	Reeves County.								
	Ross pool (near Toyah):								
604		David T. Day	Well	Leatherman	265	.9079	24.2	Dark green	H_2S.
605	East of Leatherman well; Producers Oil Co., Houston.	do	do	1		.8658	31.7	do	Do.
606	Toyah					.9126	23.4	Dark brown	
	Travis County.								
607	Waters Park					.9708	14.2	Black; brown in thin layers.	

603. Texas Univ. Min. Survey Bull. 1, p. 53. O. H. Palm, analyst.
606. Texas Univ. Min. Survey Bull. 9, p. 66. O. H. Palm, analyst.
607. Texas Univ. Min. Survey Bull. 15.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.													
			To 150° C.		150°-300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°-300°C.	
	TEXAS—continued.															
	Navarro County—Continued.															
602	Corsicana pool, Staley & Barnsdall, Corsicana.	138	1.0	.....	46.0	0.7934	51.4	0.9056	98.4	.....	3.96	0.38	Tr.	15.2	3.0	
	Pecos County.															
603	Fort Stockton.....	.....	(a)	.....	(b)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	a To 200° C.; b 200°-360° C. Distillate above 360° C., 27.02 p. ct.; residue, 45.54 p. ct., loss, 2.68 p. ct.
	Reeves County.															
	Ross pool (near Toyah):															
604	Leatherman well.....	172	.....	.....	23.0	.8449	76.7	.9302	99.7	.....	0	0	.....	28.4	6.0	
605	East of Leatherman well; Producers Oil Co., Houston.	128	6.0	0.7710	36.0	.8176	57.9	.9115	99.9	.....	0	0	.....	18.8	6.0	
606	Toyah.....	.....	16.0	.7404	24.6	.8466	60.3	.....	100.0	1.00	.....	.....	.....	.....	.....	Oil flows at 3° F.; burning point, 220° F. B. t. u. 19,440. 325°-350° C., 50 p. ct. heavy oil, loss, 5.3 p. ct.; residue, 14 p. ct. by weight. Viscosity by Engler method 20 at 23° C.
	Travis County.															
607	Waters Park.....	.....	.....	.....	58.1	.9144	.....	.....	.....	1.26	.....	.....	.....	.....	.....	B. t. u. 18,835. Distillation, 35 mm. pressure. Residue, ivory black, brilliant luster, sticky.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	UTAH.								
	San Juan County.								
608	.....	M. R. Campbell..	.....	.....	.....	0.8755	29.9	Black.....	
609	Goodridge townsite, E. L. Goodridge, Goodridge.....	E. L. Goodridge..	Well.....	1.....	225	.8363	37.4	.....do.....	
610	Do.....	.....do.....	.....do.....	4.....	263	.8264	39.4	.....do.....	
611	Monumental Oil Co.....	E. G. Woodruff...	.....do.....	Jackson.....	626	.8314	38.4	.....do.....	
612	South Side Oil Co.....	.....do.....	.....do.....	Anderson.....	300	.8202	40.7	.....do.....	
613	T. 42 S., R. 19 E.....	.....do.....	.....do.....	Arcola.....	600	.8388	36.9	Dark green.....	
	Washington County.								
614	Virgin River.....	.....	.....	.....	.....	.9116	23.6	.....	
615	Do.....	.....	.....	.....	.....	.9144	23.1	.....	
616	Do.....	.....	.....	.....	.....	.9150	23.0	.....	
617	Do.....	Clarence Gerry....	Well.....	Holohan 1.....	.....	.9180	22.5	Black.....	Sulphur.
618	Oil City.....	.....	.....	.....	.....	.8333	38.0	.....	
	Uinta County.								
619	Whiskey Run (near Dragon), Tunnel Mining Co., Dragon.	David T. Day.....	Tunnel.....	.....	.....	.9511	17.2	Brown.....	Aromatic.

614–615. The Tribune, Salt Lake City, Utah, Dec. 29, 1907.
616. Deseret Evening News, Salt Lake City, Utah, Dec. 14, 1907.
618. Henry R. Ellis, mining engineer.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	UTAH.															
	San Juan County.															
608		212	.....	.....	29.0	0.8283	71.5	0.9035	100.5	.....	5.77	3.32	.....	21.2	6.0	
609	Goodridge townsite, E. L. Goodridge, Goodridge.	90	10.0	0.7375	38.0	.7967	51.6	.8974	99.6	.....	7.31	.....	Tr.	.....	.....	
610	Do	70	12.0	.7245	36.0	.7941	49.3	.8974	97.3	0.26	6.09	.80	Tr.	20.4	1.0	
611	Monumental Oil Co	78	11.0	.7235	35.0	.7976	51.0	.8946	97.0	.18	5.29	.60	.....	14.8	6.0	Stray sand.
612	South Side Oil Co	73	12.0	.7130	36.0	.7941	49.5	.8975	97.5	.20	3.25	.49	.....	14.4	8.0	Baby or "Goodridge" sand.
613	T. 42 S., R. 19 E	97	10.0	.7395	37.0	.8021	52.0	.8986	99.0	.40	6.79	1.11	.....	19.2	6.0	Mendenhall sand.
	Washington County.															
614	Virgin River	.....	0	.....	30.63	.....	69.37	.....	100.0	.....	.....	.....	.....	.....	.....	Lubricating oil, 43 p. ct.; coke and loss, 26.37 p. ct.
615	Do	.....	.....	.....	.....	.....	.....	.....	100.0	1.38	.....	.....	.....	.....	.....	Kerosene, 52° B., 8 p. ct.; neutral oil, 35.3° B., 20 p. ct.; 36.1° B., 40 p. ct.; 33° B., 23 p. ct. Residuum containing considerable paraffin, 9 p. ct.
616	Do	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.4	.....	.....	.....	.....	Kerosene, 11.8 p. ct.; heavy signal oil, 9.5 p. ct.; light lubricating oil, 9 p. ct.; heavy lubricating oil, 55.9 p. ct.; residuum, 7.7 p. ct.; loss, 2.1 p. ct.
617	Do	60	2.1	.....	19.5	.784	78.4	.....	100.0	.45	29.4	5.9	.....	.....	.....	
618	Oil City	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Naptha, 70° to 250° C., 12.5 p. ct., 63° B.; light-burning oil 250° to 400°C., 21.2 p. ct., 51° B.; heavy-burning oil, 400° to 500°C., 19.2 p. ct., 41 B.; heavy oils, 500°C. up, 43 p. ct., 33° B.
	Uinta County.															
619	Whiskey Run (near Dragon), Tunnel Mining Co., Dragon.	250	.....	.....	28.0	.9135	70.0	.9804	98.0	.....	.....	.....	Tr.	.....	.....	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	WEST VIRGINIA.								
	Doddridge County.								
620	Eagles Mills; Chas. Stewart	M. J. Munn	Well	8		0.7941	46.3	Dark green	Like Pa. oil.
621	One mile south of Eagles Mills; Chas. Stewart	do	do	16		.7756	50.5	Medium green	Do.
622	Sullivan pool, 1 mile west Center Point, McElroy Creek; Laura Sweeney lease; South Penn Oil Co., Oil City, Pa.	do	do	2		.7874	47.8	Dark amber	Do.
623	Morgansville pool; J. W. Allen lease; H. E. Donohue, Morgansville.	do	do	1		.8014	44.7	Medium green	Do.
	Harrison County.								
624	Shinnston pool, Clay district; E. J. Whiteman lease; South Penn Oil Co., Oil City, Pa.	David T. Day	do	3	2,015	.7977	45.5	Medium amber	Do.
	Lewis County.								
625	About 1¼ miles southwest of Churchville; M. A. Egan lease; South Penn Oil Co., Oil City, Pa.	M. J. Munn	do	1		.8240	39.9	Light green	Do.
626	McDonald lease	do	do	6		.8235	40.0	Black	Do.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	WEST VIRGINIA.															
	Doddridge County.															
620	Eagles Mills; Chas. Stewart	53	16.0	0.7078	40.0	0.7797	41.6	0.8679	97.6	.....	5.10	0	0	10.8	5.0	Big Injun sand.
621	One mile south of Eagles Mills; Chas. Stewart.	63	20.0	.7018	38.0	.7778	36.0	.8552	a 94.0	.....	6.30	0	0	13.2	5.0	Big Injun sand. a Low because of very volatile hydrocarbons.
622	Sullivan pool, 1 mile west Center Point, McElroy Creek; Laura Sweeney lease; South Penn Oil Co., Oil City, Pa.	55	19.0	.7146	40.0	.7810	37.9	.8589	96.9	.....	6.02	0	0	16.0	4.0	
623	Morgansville pool; J. W. Allen lease; H. E. Donohue, Morgansville.	58	16.0	.7162	38.0	.7868	41.2	.8674	95.2	.....	5.19	0	0	16.8	4.0	First Cow Run sand.
	Harrison County.															
624	Shinnston pool, Clay district; E. J. Whiteman lease; South Penn Oil Co., Oil City, Pa.	72	14.0	.7104	40.0	.7777	44.1	.8505	98.1	.....	9.73	0	0	12.8	4.0	Fifty-foot sand.
	Lewis County.															
625	About 1½ miles southwest of Churchville; M. A. Egan lease; South Penn Oil Co., Oil City, Pa.	120	3.5	.7435	41.0	.7846	55.3	.8679	99.8	.....	6.77	0	0	14.4	5.0	
626	McDonald lease	80	9.5	.7260	36.0	.7865	53.8	.8739	99.3	.....	7.10	0	0	18.8	5.0	Gantz sand.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	WEST VIRGINIA—continued.								
	Marion County.								
627						0.8069	43.5		
	Pleasants County.								
628	Boyd heirs' farm; Horseneck	G. P. Grimsley	Well		280	.8149	41.8	Medium green	Like Pa. oil.
629	Jefferson Township; French Creek Oil Co., Marietta, Ohio.	do	do	Smith		.8173	41.3	Light green	Do.
630	Jefferson Township; French Creek Oil Co., Marietta, Ohio.	do	do	Amber		.7923	46.7	Medium green	Do.
631	McKim Township; S. Y. Ramage Oil Co., Oil City, Pa.	do	do		994	.8135	42.1	Dark green	Do.
632	Spindle Top; Schultz Farm Oil Co., St. Marys	do	do		1,040	.7896	47.3	do	Do.
633	Sugar Valley; Sherlock and Toronski, Canton, Ohio.	do	do		1,443	.7861	48.1	Light green	Do.
634	Do	do	do		635	.7735	51.0	Medium green	Do.
635	Arvilla pool, Heneghan & Hanlan Oil Co., Sistersville.	do	do		615	.7883	47.6	do	Do.
636	Lytton pool; South Penn Oil Co., Oil City, Pa	do	do			.7726	51.2	Dark amber	Do.
637	Washington Township; Elmer Edmunds & Co., St. Marys.	do	do		1,260	.7756	50.5	Green	

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°-300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°-300°C.	
	WEST VIRGINIA—continued.															
	Marion County.															
627	.....	75	15.5	0.7065	34.0	0.7865	.....	.....	.....	.....	.....	.....	.....	.....	.....	Gordon sand.
	Pleasants County.															
628	Boydheirs' farm; Horseneck.	99	17.0	.7400	35.0	.7899	47.9	0.8642	99.9	.....	6.95	0	0	4.0	4.0	Horseneck sand.
629	Jefferson Township; French Creek Oil Co., Marietta, Ohio.	140	.7	.....	48.0	.7798	50.8	.8573	99.5	.....	7.72	0	0	6.0	1.0	Maxton sand.
630	Jefferson Township; French Creek Oil Co., Marietta, Ohio.	80	22.0	.7175	36.0	.7780	40.5	.8560	98.5	.....	4.87	0	0	7.6	3.0	Do.
631	McKim Township; S. Y. Ramage Oil Co., Oil City, Pa.	119	4.0	.7475	49.0	.7811	46.2	.8642	99.2	.....	6.71	0	0	3.6	5.0	First Cow Run sand.
632	Spindle Top; Schultz Farm Oil Co., St. Marys.	73	18.0	.7160	39.5	.8003	39.7	.8607	97.2	.....	7.25	0	0	4.0	3.0	Do.
633	Sugar Valley; Sherlock and Toronski Canton, Ohio.	92	15.0	.7120	45.0	.7683	38.5	.8511	98.5	.....	6.44	0	0	6.4	3.0	Big Injun sand.
634	*Do*.....	73	19.0	.7040	45.0	.7690	36.0	.8492	100.0	.....	5.49	0	0	6.0	4.0	First Cow Run sand.
635	Arvilla pool; Heneghan & Hanlan Oil Co., Sistersville.	123	2.0	.....	68.0	.7623	29.7	.8413	99.7	.....	3.18	0	0	4.0	4.0	Do.
636	Lytton pool; South Penn Oil Co., Oil City, Pa.	68	24.5	.7060	37.0	.7753	34.0	.8549	[a]95.5	.....	4.87	0	0	7.6	4.0	Big Injun sand. [a]Low total because of escape of very volatile hydrocarbons.
637	Washington Township; Elmer Edmunds & Co., St. Marys.	53	20.0	.6950	41.0	.7673	35.5	.8584	96.5	.....	.....	0	.....	.....	.....	Big Injun sand.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	WEST VIRGINIA—continued.								
	Pleasants County—Continued.								
638	Smith Bros. & Sweeney, St. Marys	G. P. Grimsley	Well		1,234	0.7883	47.6	Green	
639	Sweeney Bros. & Co., St. Marys	do	do		1,327	.8005	44.9	do	
640	Ohio & West Virginia Oil Co., St. Marys	do	do		1,330	.7865	48.0	do	
641	Do	do	do		1,365	.7865	48.0	do	
642	J. D. Dinsmoor & Co., St. Marys	do	do		1,673	.7870	47.9	do	
643	Ohio & West Virginia Oil Co., St. Marys	do	do		590	.8041	44.1	do	
644	Do	do	do		1,130	.8074	43.4	do	
645	J. D. Dinsmoor & Co., St. Marys	do	do		546	.8041	44.1	do	
646	Grant Township; N. Y. Producers' Oil Co., Belmont pool.	do	do		1,400	.7870	47.9	do	
647	Jefferson Township; Dinsmoor Oil Co., St. Marys	do	do			.7982	45.4	do	
	Ritchie County.								
648	Grant Township; Cairo Oil Co., Cairo; Moats (Cairo) Pool.	G. P. Grimsley	Well		1,717	.8895	27.4	Brown	Like Pa. oil.
649	Do	do	do		1,842	.8102	42.8	Light green	Do

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	WEST VIRGINIA—continued.														
	Pleasants County—Contd.														
638	Smith Bros. & Sweeney, St. Marys.	73	15.0	0.7076	43.5	0.7688	39.4	0.8578	97.9	.....	9.00	0	.....	.....	.....	
639	Sweeney Bros. & Co., St. Marys.	97	14.0	.7173	42.0	.7700	43.4	.8573	99.4	.....	6.68	0	.....	.....	.....	Keener sand.
640	Ohio & West Virginia Oil Co., St. Marys.	68	18.0	.7050	39.0	.7716	39.3	.8587	96.3	.....	7.86	0	.....	.....	.....	Do.
641	Do	59	20.0	.7080	36.0	.7744	39.1	.8600	95.1	.....	8.43	0	.....	.....	.....	Do.
642	J. D. Dinsmoor & Co., St. Marys.	70	16.5	.7111	41.0	.7694	34.5	.8573	92.0	.....	5.00	0	.....	.....	.....	Big Injun sand.
643	Ohio & West Virginia Oil Co., St. Marys.	89	18.0	.7256	39.5	.7818	42.8	.8653	100.3	.....	8.92	0	.....	.....	.....	First Cow Run sand.
644	Do	85	16.0	.7202	37.0	.7784	46.2	.8663	99.2	.....	5.46	0	.....	.....	.....	Salt sand.
645	J. D. Dinsmoor & Co., St. Marys.	87	10.0	.7220	45.0	.7686	44.4	.8621	99.4	.....	5.56	0	.....	.....	.....	First Cow Run sand.
646	Grant Township; N. Y. Producers' Oil Co., Belmont pool.	53	27.5	.7093	33.0	.7826	36.7	.8666	97.2	.....	2.45	0	.....	.....	.....	Berea sands.
647	Jefferson Township; Dinsmoor Oil Co., St. Marys.	74	8.0	.7165	43.5	.7686	42.5	.8613	94.0	.....	6.93	0	.....	.....	.....	First Cow Run sand.
	Ritchie County.															
648	Grant Township; Cairo Oil Co., Cairo; Moats (Cairo) pool.	226	.....	.....	11.0	.8525	88.7	.8906	99.7	.....	4.08		0	32.8	7.0	Salt sand.
649	Do	118	6.0	.7460	46.0	.7791	48.0	.8547	100.0	.....	6.30	0	0	6.0	3.0	Keener sand.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60° F.		Color.	Odor.
						Specific.	Baumé.		
	WEST VIRGINIA—continued.								
	Ritchie County—Continued.								
650	Grant Township; Cairo Oil Co., Cairo; Davidson (Cairo) pool.	G. P. Grimsley ...	Well.....	.....	1,538	0.8102	42.8	Medium green.....	Like Pa. oil.
651	Oil Ridge pool, Grant Township; R. G. Gillespie Oil Co., Pittsburgh, Pa.	.....do.....	.....do.....	.....	.....	.8000	45.0	.....do.....	Do.
652	Elm Run pool, Bunnell Oil Co., Parkersburg.....	.....do.....	.....do.....	.....	2,145	.8000	45.0	Medium amber....	Do.
653	Volcano pool, Grant Township; Mount Farm Oil Co., Volcano.	.....do.....	.....do.....	.....	600	.8130	42.2	Medium green.....	Do.
654	Long Run field, Grant Township; Bando Oil Co., Baltimore, Md.	.....do.....	.....do.....	.....	1,588	.8037	44.2	Dark green.....	Do.
655	McFarlan pool, Murphy Township; Cairo Oil Co., Cairo.	.....do.....	.....do.....	.....	1,494	.8005	44.9	.....do	Do.
656	Do.....	.....do.....	.....do.....	.....	1,549	.7705	51.7	Light green.....	Do.
657	Do.....	.....do.....	.....do.....	Donaldson.....	1,534	.8149	41.8	Medium green.....	Do.
658	Cairo pool, Grant Township; Ellen Hall farm; Cairo Oil Co., Cairo.	.....do.....	.....do.....	1.....	1,654	.8154	41.7	Medium amber....	Do.
659	Cairo pool, Grant Township; Cairo Oil Co., Cairo; Biddie Deem farm.	.....do.....	.....do.....	2.....	1,491	.8051	43.9	Dark green.....	Do.

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Analyses of petroleum from various parts of the United States—Continued.

	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.	Total.					Crude	150°–300° C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	WEST VIRGINIA—continued.														
	Ritchie County—Continued.														
650	Grant Township: Cairo Oil Co., Cairo; Davidson (Cairo) pool.	105	7.5	0.7310	45.5	0.7781	47.2	0.8631	100.2	.....	7.84	0	0	7.2	4.0	Salt sand.
651	Oil Ridge pool, Grant Township; R. G. Gillespie Oil Co., Pittsburgh, Pa.	87	17.0	.7161	39.0	.7780	43.5	.8610	99.5	.....	6.36	0	0	7.2	3.0	Do.
652	Elm Run pool; Bunnel Oil Co., Parkersburg.	93	10.0	.7175	44.0	.7717	44.9	.8610	98.9	.....	9.15	0	0	6.4	4.0	Keener sand.
653	Volcano pool, Grant Township; Mount Farm Oil Co., Volcano.	115	7.0	.7360	43.0	.7762	47.7	.8906	97.7	.....	7.17	0	0	7.6	3.0	Heavy oil sand.
654	Long Run field, Grant Township; Bando Oil Co., Baltimore, Md.	108	3.0	.7370	49.0	.7659	48.0	.8573	100.0	.....	6.92	0	0	8.0	4.0	Salt sand.
655	McFarlan pool, Murphy Township; Cairo Oil Co., Cairo.	90	16.0	.7175	39.0	.7773	45.0	.8618	100.0	.....	4.22	0	Tr.	8.4	2.0	Cairo salt sand.
656	Do.....	65	22.0	.6930	37.0	.8076	35.2	.8516	[a] 94.2	.....	5.98	.....	.....	6.4	3.0	Cairo salt sand. [a] Low total because of escape of very volatile hydrocarbons; average of three distillations.
657	Do.....	130	2.5	.7420	46.0	.7741	51.4	.8565	99.9	.....	9.05	0	.....	7.6	4.0	Cairo salt sand.
658	Cairo pool, Grant Township; Ellen Hall farm; Cairo Oil Co., Cairo.	137	1.0	.....	49.0	.7767	50.1	.8552	100.1	.....	8.16	0	Tr.	6.0	3.0	Big Injun sand.
659	Cairo pool, Grant Township; Cairo Oil Co., Cairo; Biddie Deem farm.	90	10.0	.7235	39.5	.7761	48.1	.8610	97.6	.....	9.48	0	Tr.	6.4	3.0	Cairo salt sand.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	WEST VIRGINIA—continued.								
	Ritchie County—Continued.								
660	Highland pool, Clay Township; Carter Oil Co., Sistersville.	G. P. Grimsley...	Well.....	.....	.....	0.7865	48.0	Light green.....	Like Pa. oil.
661	Whiskey Run pool, Clay Township; South Penn Oil Co., Oil City, Pa.	.....do.....	.....do.....	.....	1,786	.7684	52.2	Medium amber....	Do.
662	Wolf Pen pool, Grant Township; McBride Oil Co., Pittsburgh, Pa.	.....do.....	.....do	.....	1,750	.7874	47.8	Dark green	Do.
663	Wolf Pen pool, Grant Township; Sarber Oil & Gas Co., Parkersburg.	.....do.....	.....do.....	.....	1,950	.7804	49.4	Light green.....	Do.
664	Harrisville pool, Union Township; Hartman Oil Co., Pittsburgh, Pa.	.....do.....	.....do.....	.....	.....	.7839	48.6	Light amber.....	Do.
665	Harrisville pool, Union Township; Harrisville Heat & Light Co., Harrisville.	.....do.....	.....do.....	.....	1,850	.7977	45.5	Dark amber.....	Do.
666	Clay Township; McKelvey Oil Co., Pittsburgh, Pa...	.....do.....	.....do.....	.....	1,790	.7959	45.9	Medium amber....	Do.
667	Flanagan pool, Union Township; Carter Oil Co., Sistersville.	.....do.....	.....do.....	.....	.....	.7986	45.3	Dark green.....	Do.
668	Inland pool, Union Township; South Penn Oil Co., Oil City, Pa.	.....do.....	.....do.....	.....	.....	.7986	45.3	.....do.....	Do.

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Analysis of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	WEST VIRGINIA—continued.														
	Ritchie County—Continued.														
660	Highland pool, Clay Township; Carter Oil Co., Sistersville.	79	11.0	0.7045	44.0	0.7706	41.1	0.8513	96.1	.....	3.61	0	Tr.	6.4	4.0	Keener sand.
661	Whiskey Run pool, Clay Township; South Penn Oil Co., Oil City, Pa.	70	24.0	.7010	37.5	.7711	34.5	.8516	96.0	.....	7.37	0	Tr.	8.4	4.0	Big Injun sand
662	Wolf Pen pool, Grant Township; McBride Oil Co., Pittsburgh, Pa.	92	7.0	.7055	50.0	.7616	40.4	.8587	97.4	.....	5.35	0	.....	7.2	3.0	Keener sand.
663	Wolf Pen pool, Grant Township; Sarber Oil & Gas Co., Parkersburg.	84	13.5	.7000	39.0	.7638	41.8	.8495	[a] 94.3	.....	5.00	0	(?)	8.4	4.0	Keener sand. [a] Low because of escape of very volatile hydrocarbons.
664	Harrisville pool, Union Township; Hartman Oil Co., Pittsburgh, Pa.	71	20.0	.7145	39.0	.7763	38.3	.8537	97.3	.....	7.44	0	.....	6.8	3.0	Squaw sand.
665	Harrisville pool, Union Township; Harrisville Heat & Light Co., Harrisville.	93	17.0	.7265	42.0	.7770	40.9	.8485	99.9	.....	5.32	0	.....	5.6	4.0	Big Injun sand.
666	Clay Township; McKelvey Oil Co., Pittsburgh, Pa.	103	6.5	.7300	53.0	.7709	40.7	.8485	100.2	.....	6.52	0	.....	5.6	4.0	Squaw sand.
667	Flanagan pool, Union Township; Carter Oil Co., Sistersville.	74	15.0	.7170	41.0	.7804	42.3	.8647	98.3	.....	6.33	0	.....	7.2	4.0	Keener sand.
668	Inland pool, Union Township; South Penn Oil Co., Oil City, Pa.	75	11.0	.7085	38.5	.7731	45.4	.8618	[a] 94.9	.....	6.58	0	.....	7.6	4.0	Maxton and Big Injun sand. [a] Low because of very volatile hydrocarbons.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	WEST VIRGINIA—continued.								
	Ritchie County—Continued.								
669	Prunty pool, Union Township; Carter Oil Co., Sistersville.	G. P. Grimsley	Well			0.7701	51.8	Dark green	Like Pa. Oil.
670	Cairo pool, Grant Township; J. H. Hatfield lease; Cairo Oil Co., Cairo.	M. J. Munn	do	2		.8144	41.9	Medium green	Do.
	Tyler County.								
671	J. F. Ingraham. Lot No. 1	M. J. Munn	do		2,670	.8078	43.3	Medium amber	Do.
	Wood County.								
672	Pohick pool, Williams Township; Clark & Ritchie Co., Marietta, Ohio.	G. P. Grimsley	do			.8140	42.0	Dark green	Do.
673	Braz pool, Williams Township; Clark & Ritchie Co., Marietta, Ohio.	do	do		634	.7950	46.1	Medium green	Do.
674	Williams Township; Henderson Oil Co., Marietta, Ohio.	do	do		850	.8055	43.8	Brown	Do.
675	Eppelsin pool, Williams Township; Mallory Bros. and Stewart, Parkersburg.	do	do		920	.8111	42.6	Dark green	Do.
676	Union Township; McGinnis Oil Co., Williamstown	do	do		1,215	.8250	39.7	do	Do.

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Analysis of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300° C.	
	WEST VIRGINIA—continued.														
	Ritchie County—Continued.														
669	Prunty pool, Union Township; Carter Oil Co., Sistersville.	122	3.0	0.7440	47.0	0.7771	50.5	0.8581	100.5	.....	8.67	0	.....	5.6	4.1	Big Injun sand.
670	Cairo pool, Grant Township; J. H. Hatfield lease; Cairo Oil Co., Cairo.	58	17.0	.7097	36.0	.7846	44.0	.8615	97.0	.....	7.30	0	Tr.	.....	6.0	
	Tyler County.															
671	J. F. Ingraham. Lot No. 1..	70	14.0	.7163	38.0	.7840	46.7	.8621	98.7	.....	6.11	0	.....	12.8	5.0	Alvy-Gordon sand.
	Wood County.															
672	Pohick pool, Williams Township; Clark & Ritchie Co., Marietta, Ohio.	97	10.0	.7190	39.0	.7766	50.3	.8679	99.3	.....	5.89	0	Tr.	11.2	3.0	Macksburg and Maxton sand.
673	Braz pool, Williams Township; Clark & Ritchie Co., Marietta, Ohio.	73	10.0	.7045	42.0	.7420	44.3	.8658	98.3	.....	6.32	0	Tr.	10.4	4.0	First Cow Run sand.
674	Williams Township; Henderson Oil Co., Marietta, Ohio.	98	13.0	.7245	41.0	.7776	46.2	.8608	100.2	.....	5.33	0	Tr.	9.2	4.0	Do.
675	Eppelsin pool, Williams Township; Mallory Bros. and Stewart, Parkersburg.	110	3.0	.7320	47.0	.7721	47.1	.8679	97.1	.....	4.99	0	Tr.	3.6	4.0	Second Cow Run sand.
676	Union Township; McGinnis Oil Co., Williamstown.	131	3.0	.....	44.0	.7766	51.4	.9265	98.4	.....	5.61	0	Tr.	11.2	4.0	Salt sand.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	WEST VIRGINIA—continued.								
	Wood County—Continued.								
677	Union Township; McGinnis Oil Co., Williamstown..	G. P. Grimsley ...	Well.....	.....	1,069	0.8023	44.5	Dark green	Like Pa. oil.
678	Williams Township; Consolidated Oil Co, Pittsburgh, Pa.	.....do.....	.....do.....	.....	770	.8009	44.8	.....do.....	Do.
679	Williams Township; Lydecker Tool Co., Marietta, Ohio.	.....do.....	.....do.....	.....	.....	.8526	34.2	.....do.....	Do.
680	Volcano field, Walker Township (lubricating oil); canic Oil and Gas Co., Parkersburg.	.....do.....	.....do.....	.....	350	.8750	30.0	.....do.....	Do.
681	Volcano pool, Walker Township; Volcanic Oil and Gas Co., Parkersburg.	.....do.....	.....do.....	.....	600	.8429	36.1	.....do.....	Do.
	WYOMING.								
682	Norwood Spring.....	.....	.....	.....	.....	.8822	28.7	.....	
	Big Horn County.								
683	Bighorn basin, Greybull field, 2 miles southwest of Byron; Montana-Wyoming Oil Co.	Robt. Anderson...	Well.....	1, 2, 5.....	550–600	.8140	42.0	Dark amber.....	

682. Wyoming Ter. Geologist's Report, 1887. Louis D. Ricketts, W. H. Kent, analysts.

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Analysis of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300° C.	
	WEST VIRGINIA—continued.															
	Wood County—Continued.															
677	Union Township; McGinnis Oil Co., Williamstown.	70	11.5	0.7095	36.5	0.7748	47.8	0.8676	[a] 95.8	.....	5.90	0	Tr.	12.0	4.0	Second Streak Salt sand. [a] Low total because of escape of very volatile hydrocarbons; average of three distillations.
678	Williams Township; Consolidated Oil Co., Pittsburgh, Pa.	87	17.0	.7205	38.0	.7766	44.3	.8615	99.3	.....	5.69	0	0	10.4	3.0	First Cow Run sand.
679	Williams Township; Lydecker Tool Co., Marietta, Ohio.	170	.....	.....	31.0	.7949	69.1	.8907	100.1	.....	8.84	0	0	0	4.0	Berea sand.
680	Volcano field, Walker Township (lubricating oil); Volcanic Oil and Gas Co., Parkersburg.	165	.....	.....	16.0	.8356	82.4	.8872	98.4	.....	0	0	Much	21.6	5.0	Heavy oil sand.
681	Volcano pool, Walker Township; Volcanic Oil and Gas Co., Parkersburg.	123	1.5	.....	33.0	.7954	65.8	.8863	100.3	.....	5.81	0	Much	14.0	4.0	Keener sand, heavy oil sand, Big Injun sand.
	WYOMING.															
682	Norwood Spring.....	.....	[a] 5.07	.8051	[b] 75.33	.8421	19.60	.....	100.0	.....	.....	.....	.....	.....	.....	[a] 26°–130° C.; [b] 130°–260° C.
	Big Horn County.															
683	Bighorn basin, Greybull field, 2 miles southwest of Byron; Montana-Wyoming Oil Co.	85	8.5	.7446	56.0	.8036	33.4	.869	97.9	0.09	3.78	.....	.....	11.2	12.0	Colorado shale; wells close together.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baume.		
	WYOMING—continued.								
	Big Horn County—Continued.								
684	SE. cor. lot 2, sec. 17, T. 52 N., R. 93 W.; bluff west of Bighorn River; Bighorn Oil & Gas Co.	Robt. Anderson ..	Well.....	1.....	975	0.7821	49.0	Green.....	
685	Do.....	....do.....	....do.....	1.....	a 350	.8235	40.0	Dark amber.....	
686	Bonanza field: T. 49 N., R. 91 W. (Jan., 1902).....	.....	Spring.....	.....	.....	.8450	35.7	Bright green; red by transmitted light.	
687	T. 49 N., R. 91 W. (Sept. 24, 1902).....	.....	....do.....	.....	.....	.8500	34.7	.....do.....	
688	Sec 13, T. 49 N., R. 91 W.....	.....	Well.....	Henderson.....	.....	.8446	35.8	Strong green fluorescence, color red.	
689	Cottonwood, T. 47 N., R. 90 W.....	.....	.....	.....	.....	.9020	25.2	Brownish red by transmitted light; dark green by reflected light.	
	Converse County.								
690	Douglas.....	.....	.....	.....	.....	.9610	15.7	.....	
691	Do.....	.....	.....	.....	.....	.9210	22.0	.....	

686, 687, 689–691. Wyoming Univ. Bull. 6 E. E. Slosson, analyst.
688. Wyoming Mines and Minerals, 1904. E. E. Slosson, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.					Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	WYOMING—continued.															
	Big Horn County—Continued.															
684	SE. cor. lot 2, sec. 17, T. 52 N., R. 93 W.; bluff west of Bighorn River; Bighorn Oil & Gas Co	68	14.0	0.7400	42.0	0.7706	37.0	0.8516	93.0	0.005	7.04	.....	.....	32.4	7.0	Sand in lower part of Colorado shale.
685	Do	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Colorado shale. [a] Small quantity of oil in bailer.
	Bonanza field:															
686	T. 49 N., R. 91 W. (Jan., 1902).	.....	10.0	.736	[a]50.0	.8194	40.0	.....	100.0	.0149	.....	.....	.....	.....	.....	13° F. added on account of altitude of Laramie, Wyo. [a] 150°–310° C. 300 c. c. distilled in 10 fractions 30 c. c. each.
687	T. 49 N., R. 91 W. (Sept. 24, 1902).	.....	[a]10.0	.762	[b]40.0	.8275	50.0	.....	100.0	.....	.....	.....	.....	.....	.....	[a] 67°–164° C.; [b] 164°–304.5° C. 13° F. added on account of altitude of Laramie, Wyo. 280 c. c. distilled in 10 fractions.
688	Sec. 13, T. 49 N., R. 91 W.	.....	[a]10.0	.736	[b]50.0	.....	40.0	.....	100.0	.....	.....	.....	.....	.....	.....	Paraffin 2 to 4 p. ct. [a] 80°–142° C.; [b] 142°–303° C.
689	Cottonwood, T. 47 N., R. 90 W.	.....	[a]10.0	.....	[b]40.0	.....	50.0	.....	100.0	.....	.....	.....	.....	.....	.....	[a] To 164° C.; [b] 164°–305.5° C.
	Converse County.															
690	Douglas	.....	.....	.....	[a]9.81	.884	90.19	.....	100.0	.....	.....	.....	.....	.....	.....	[a] 179.2°–315° C. 13° F. added on account of altitude of Laramie, Wyo. 480.5 grams distilled, which contained 30 grams of water.
691	Do	.....	.....	.....	[a]54.6	.8689	45.4	.....	100.0	.....	.....	.....	.....	.....	.....	Oil sand retorted and oil distilled. 13° F. added on account of altitude of Laramie, Wyo. [a] 177.2°–297.2° C.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	WYOMING—continued.								
	Converse County—Continued.								
692	No. 203	V. H. Barnett	Well			0.8439	35.9	Olive green	
693	No. 6	do	do	2		.9309	20.4	Dark green	
694	No. 57, 6 miles southeast of Glenrock	do	do		600	.9743	13.7	do	
	Crook County.								
695	Belle Fourche		do			.9150	23.0	Bright red by transmitted light; dark green by reflected light.	
696	Moorcroft; Butte Crude Petroleum Co					.9390	19.1		
	Fremont County.								
697	Lander		Washakie spring			.8725	30.5	Bright red by transmitted light; green by reflected light.	
699	Do	C. H. Wegemann				.9126	23.4	Dark brown	
700	Do	do				.9121	23.5	do	
701	Do	do				.9126	23.4	do	
702	Do	do				.9091	24.0	do	
703	Do	do				.8121	42.4	Green	
704	Near Dallas, T. 30 N., R. 99 W	E. G. Woodruff	Well	3	750	.9198	22.2	Dark brown	

695. Wyoming Univ. Bull. 3. E. E. Slosson, analyst.
696. From 1906 statistical card, U. S. Geol. Survey.
697. Wyoming Univ. Bull. 2. E. E. Slosson, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	WYOMING—continued.															
	Converse County—Contd.															
692	No. 203	80	8.0	0.7205	38.5	0.7928	50.2	0.9340	96.7	.....	2.0	.....	.....	.....	.....	
693	No. 6	235	.....	.....	6.0	.8605	82.2	.9434	[a] 88.8	.....	.....	.....	Tr.	.....	.....	[a] Distillation sample included much sediment.
694	No. 57, 6 miles southeast of Glenrock.	225	.....	.....	2.0	.....	97.1	.9852	99.1	.....	.....	.....	2	.....	.....	
	Crook County.															
695	Belle Fourche	.....	.....	.....	[a] 22.38	.8485	77.62	.....	100.0	0.303	.....	.....	.....	.....	.....	[a] Up to 297° C.; burning point, 149° C. Viscosity by Engler method, 37.7 at 20° C.; freezing point, 0° C.
696	Moorcroft; Butte Crude Petroleum Co.	.....	3.0	.....	40.0	.....	57.0	.....	100.0	.....	.....	.....	.....	.....	.....	(Analysis made by Von Schuls & Son, Denver, Colo.)
	Fremont County.															
697	Lander	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Sample had been weathered and had lost some of its lighter constituents. Viscosity 1.55 at 20° C., Engler method.
699	Do	120	2.0	.....	23.5	.8041	69.9	.9543	95.4	.....	.91	4.02	.....	46.4	4.0	
700	Do	93	2.0	.....	21.0	.8067	75.2	.9589	98.2	.....	1.27	5.69	.....	50.8	4.0	
701	Do	105	1.5	.....	24.0	.8018	73.9	.9605	99.4	.....	.90	11.04	.....	58.0	4.0	
702	Do	108	2.5	.....	23.0	.8047	73.1	.9589	98.6	.....	.62	15.26	.....	50.8	9.0	
703	Do	77	14.0	.7244	41.0	.7999	41.1	.8755	96.1	.....	5.85	0	.....	10.4	5.0	
704	Near Dallas, T. 30 N., R. 99 W.	93	2.5	.....	22.0	.....	.....	.....	.....	.....	.....	.....	.....	50.4	.....	Flask broke. Water in oil.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	WYOMING—continued.								
	Fremont County—Continued.								
705	Near Dallas, T. 30 N., R. 99 W.	E. G. Woodruff	Well	2	400	0.9126	23.4	Dark brown	
706	Do	do	do	10	825	.9121	23.5	do	
707	Do	do	do	11	965	.9126	23.4	do	
708	Do	do	do	13	697	.9091	24.0	do	
709	Popo Agie, near Lander					.9000	25.6	Almost black; red-brown by transmitted light.	
710	Big Horn Basin	C. W. Washburne	Well			.8315	38.4	Transparent red	
711	Shoshone; T. 1 S., R. 1 E. W. M.	T. G. Burnet	Shale spring	12		.8573	33.3	Light green	
712	Do	do	Tar spring			.9950	10.7	Black	
713	Plunkett well (near oil spring), N. ½ NE. ¼ sec. 26, T. 1 S., R. 1 E., Wind River.	E. G. Woodruff	Well		250	.8121	42.4	Light green	Like Pa. oil.
714	Do	do	do		300	.8121	42.4	do	Do.
715	Shoshone Oil Co. No. 1	D. F. Hewett	do			.8454	35.6	Dark green	
716	Shoshone Oil Co. No. 2	do	do			.8335	37.9	Green	
717	Shoshone Basin					.9110	23.7		
718	Do					.9450	18.2		
719	Shoshone Field					.9960	10.6	Black and thick	
720	Do								
721	Do					.9660	14.9		

709. Wyoming Univ. Bull. 2. E. E. Slosson, analyst; U. S. Geol. Survey Mineral Resources, 1897, 1898.
717–718. Soc. Chem. Indust. Jour., No. 6, p. 408. Sir Boverton Redwood.
719. Wyoming Univ. Bull. 2. E. E. Slosson, analyst.
720–721. Wyoming Ter. Geologist Report, 1886. Wyner and Harland, analysts.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (° C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude.	150°–300°C.	
	WYOMING—continued.															
	Fremont County—Continued.															
705	Near Dallas, T. 30 N., R. 99 W.	120	2.0	.....	23.5	0.8041	69.9	0.9543	95.4	.....	0.91	4.02	.....	46.4	4.0	
706	Do	93	2.0	.....	21.0	.8067	75.2	.9589	98.2	.....	1.27	5.69	.....	50.8	4.0	
707	Do	105	1.5	.....	24.0	.8018	73.9	.9605	99.4	.....	.90	11.04	.....	58.0	4.0	
708	Do	108	2.5	.....	23.0	.8047	73.1	.9589	98.6	.....	.62	15.26	.....	50.8	9.0	
709	Popo Agie, near Lander	95	2–5	.....	30–40	.810–.830	.....	.....	.....	0.66	4.0	.....	.....	.....	.....	Fire test 58° C.; viscosity by Engler method, 13.28 at 20° C. Lubricating oil, sp. gr. 0.910–0.940, 35 to 40 p. ct.; coke, 7 to 10 p. ct.
710	Big Horn Basin	77	14.0	0.7220	45.5	.7800	40.5	.....	100.0	.....	.....	.....	.....	.....	.....	
711	Shoshone; T. 1 S., R. 1 E., W. M.	143	Tr.	.....	51.0	.8271	48.7	.8929	99.7	.....	.....	.....	.....	.....	.....	
712	Do															
713	Plunkett well (near oil spring), N. ½ NE. ¼ sec. 26, T. 1 S., R. 1 E., Wind River.	83	13.0	.7183	40.0	.7943	45.9	.8563	98.9	.....	4.51	0	.....	8.4	5.0	
714	Do	77	14.0	.7244	41.0	.7994	41.1	.8755	96.1	.....	5.85	0	.....	10.4	5.0	
715	Shoshone Oil Co. No. 1	190	.....	.....	37.0	.8169	59.6	.9278	96.6	.....	7.6	.....	(a)	.....	.....	a Present.
716	Shoshone Oil Co. No. 2	160	.....	.....	48.0	.8009	52.4	.8696	100.4	.....	8.0	0	0	.....	.....	
717	Shoshone Basin	.....	2.5	.....	27.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Lubricating oil, 52.5 p. ct., sample 6.
718	Do	.....	0	.....	10.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Lubricating oil, 72.5 p. ct., sample 7.
719	Shoshone Field	.....	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Only small quantity distilled; water in sample so that flash point not determined.
720	Do	.....	0	.....	17.0	.807	83.0	.....	100.0	.....	.....	.....	.....	.....	.....	Lubricating oil, sp. gr. 0.810–0.824, 21 p. ct.; sp. gr. 0.840–0.844, 20 p. ct.; sp. gr. 0.906, 27 p. ct. Coke, 14 p. ct.
721	Do	.....	0	.....	.....	.....	.....	.....	100.0	.....	.....	.....	.....	.....	.....	Lubricating oil, sp. gr. 0.842–0.847, 19 p. ct.; sp. gr. 0.926–0.935, 45 p. ct.; sp. gr. 0.957, 12.5 p. ct. Coke, 14.5 p. ct.; loss, 9 p. ct.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	WYOMING—continued.								
	Natrona County.								
722	Rattlesnake Basin					0.9920	11.1	Black	
723	Salt Creek; Pa. Oil Co		Well			.9095	23.9	Bright red by transmitted light, dark green by reflected light.	
724	Do							Green	
725	Dutch No. 1 (sample 1)	C. H. Wegemann	Well		+1,000	.8221	40.3	do	
726	Dutch No. 1 (sample 2)	do	do			.8255	39.6	do	
727	Dutch No. 1 (sample 3)	do	do			.8221	40.3	do	
728	Shannon No. 10	do	do		847	.9097	23.9	Olive green	
729	Shannon No. 12	do	do		843	.9085	24.1	Green	
730	Iba	do	do			.8314	38.4	do	
731	Stock	do	do			.8563	33.5	Dark green	
	Powder River (Tisdale field):								
731a	Oil Canyon	do	Open pit			.9180	22.5	Black	Sulphur.
732	Salt Canyon	do	Oil seep			.9066	24.6	do	
733	Do	do	Tunnel			.9106	23.75	do	
734	Trail Canyon	do	Open pit			.9150	23.0	do	
735	Oil Mountain district		Spring						
	Uinta County.								
736	Spring Valley		Well	Union Pacific					
737	Do		do	do		.8211	40.5		

722. Wyoming Ter. Geologist Report, 1886. Wyner and Harland, analysts.
723. Wyoming Univ. Bull. 1. E. E. Slosson, analyst.
724. U. S. Geol. Survey Mineral Resources, 1894, 1895. Analysis by Wilbur C. Knight.
735. Wyoming Univ. Bull. 4. E. E. Slosson, analyst.
736. U. S. Geol. Survey Bull. 285, 1906. Analysis by Theodore Price and Son.
737. U. S. Geol. Survey Bull. 285, 1906. G. W. Gray, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.												
			To 150° C.		150°-300° C.		Residuum.		Total.							Crude	150°-300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.						
	WYOMING—continued.														
	Natrona County.														
722	Rattlesnake Basin	.....	.....	.....	.....	.....	100.0	.....	100.0	.....	.....	.....	.....	.....	.....	Lubricating oil, sp. gr. 0.854–0.860, 29.80 p. ct.; sp. gr. 0.933, 7.40 p. ct.; sp. gr. 0.950, 23 p. ct. Coke, 30 p. ct.
723	Salt Creek; Pa. Oil Co.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Distillations made in various ways. Viscosity at 20° C., 15.74, Engler method.
724	Do	.....	1.2	0.739	12.13	0.8313	86.67	.....	100.0	.....	.....	.....	.....	.....	Lubricating oil, 76.765 p. ct.; coke, 3.0075 p. ct.; ash, 0.148 p. ct.; loss, 6.4816 p. ct.
725	Dutch No. 1 (sample 1)	76	8.0	.7220	38.0	.7881	49.3	0.8963	95.3	.....	4.97	.....	.....	16.4	4.0	
726	Dutch No. 1 (sample 2)	76	11.0	.7210	36.0	.7934	50.0	.9088	97.0	.....	4.91	.....	.....	13.2	4.0	
727	Dutch No. 1 (sample 3)	66	16.0	.7114	29.0	.7911	52.4	.8861	97.4	.....	6.44	.....	.....	14.4	5.0	
728	Shannon No. 10	204	.....	.....	12.5	.7673	86.9	.9192	99.4	.....	1.14	.....	.....	15.2	6.0	
729	Shannon No. 12	213	.....	.....	10.0	.8673	86.6	.9211	96.6	.....	.....	.....	.....	14.8	8.0	
730	Iba	84	11.0	.7215	34.0	.7875	54.0	.9023	99.0	.....	5.56	.....	.....	13.2	4.0	
731	Stock	126	1.0	.....	36.0	.7854	62.4	.9032	99.4	.....	5.63	.....	.....	13.2	4.0	
	Powder River (Tisdale field):															
731a	Oil Canyon	190	.....	.....	14.0	.8546	84.3	.9302	98.3	0.38	0	2.31	0.19	33.2	6.0	
732	Salt Canyon	.....	.....	.....	.....	.....	.....	.....	.....	.27	.....	.....	.....	.....	.....	
733	Do	240	.....	.....	16.5	.8498	80.6	.9226	97.1	.55	3.12	2.30	2.42	27.2	8.0	
734	Trail Canyon	210	.....	.....	20.5	.8541	78.7	.9356	99.2	.38	0	2.58	.10	31.6	8.0	
735	Oil Mountain district	.....	.....	.....	a5.0	.860	95.0	.....	100.0	.10	.....	.....	.....	.....	.....	a 207°–307° C. Flash, 104° C.; fractionated into 20 portions.
	Uinta County.															
736	Spring Valley	.....	28.0	.....	24.0	.....	48.0	.....	100.0	.....	.....	.....	.....	.....	.....	Signal oil, 8 p. ct.; lubricating oil, 23 p. ct.; paraffin, 17 p. ct.
737	Do	.....	19.0	.....	35.0	.....	46.0	.....	100.0	.....	.....	.....	.....	.....	.....	Lubricating oil, 42 p. ct.; coke, 1.8 p. ct.; loss, 2 p. ct. Sample taken June 29, 1902, from car loaded Jan. 26, 1902.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	WYOMING—continued.								
	Uinta County—Continued.								
738	Spring Valley		Well	Union Pacific		0.8100	42.8		
739	Spring Valley; at 650 feet, sand		do	do		.8250	39.7		
740	Spring Valley; Pittsburg-Salt Lake Oil Co		do			.8100	42.8		
741	Spring Valley					.8329	38.1	Olive green	
742	Do					.8176	41.2		
743	Sec. 10, T. 26 N., R. 113 W	A. R. Schultz	Pit			.9415	18.7	Dark brown	Oxidized.
744	Carter district		Spring			.9240	21.5	Black	
745	Twin Creek district		do			.9352	19.7	do	
	Weston County.								
746	Newcastle; near B. & M. Rwy		Spring			.9230	21.7	Red-brown by transmitted light, dark green by reflected light, opaque and viscous.	

738. U. S. Geol. Survey Bull. 285, p. 352, 1906.
739. U. S. Geol. Survey Bull. 285, 1906. Louis Falkenau, analyst.
740. U. S. Geol. Survey Bull. 285, 1906. C. F. Mabery, analyst.
741. U. S. Geol. Survey Mineral Resources, 1902, 1904. F. Salathe, analyst
742. U. S. Geol. Survey Mineral Resources, 1902, 1904. Wilbur C. Knight.
744–745. Wyoming Univ. Bull. 3. E. E. Slosson, analyst.
746. Wyoming Univ. Bull. 5. E. E. Slosson, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.							Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.												
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	WYOMING—continued.														
	Uinta County—Continued.														
738	Spring Valley	.....	20–30	.....	30–40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Paraffin, 10–20 p. ct. Fraction, 77°–130° C., sp. gr. 0.723; 130°–170° C., sp. gr. 0.754; 170°–200° C., sp. gr. 0.780; 200°–259° C., sp. gr. 0.804.
739	Spring Valley; at 650 feet, sand.	.....	[a]15.0	0.740	[b]33.1	0.802	49.5	.....	97.6	.....	.....	.....	.....	.....	.....	[a] 19°–150° C.; [b] 150°–255° C. 255°–317°C., 27.1 p. ct.; sp. gr. 0.830; bituminous soluble, 1 p. ct.; carbon and ash, 1 p. ct.
740	Spring Valley; Pittsburg-Salt Lake Oil Co.	.....	21.3	.7179	[a]39.7	.8046	39.0	.....	100.0	0.03	.....	.....	.....	.....	.....	[a] 150°–305° C. 305°–350° C., 16.4 p. ct.; paraffin, 6.2 p. ct.; residue, 7.2 p. ct. Oil begins to crack at 350° C.
741	Spring Valley	.....	27.0	.....	25.5	.....	47.5	.....	100.0	.....	.....	.....	.....	.....	.....	Signal oil, 7 p. ct.; lubricating oil, 40.5 p. ct.
742	Do	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Sample taken at first strike, fractional distillations 10 parts: 77°–130° C., 120°–170° C., 170°–200° C., 200°–259° C., 259°–292° C., 292°–320° C., 320°–350° C., 350°–370° C., 370°–380° C., 380°–400° C. Paraffin, 10–15 p. ct.
743	Sec. 10, T. 26 N., R. 113 W.	90	Tr.	.....	34.0	.89	66.0	.....	100.0	.....	.....	.....	.....	.....	.....	
744	Carter district	.....	.....	.....	.....	.....	.....	.....	.....	10	.....	.....	.....	.....	.....	Freezing point, 0° C. 277°–357° C., 41.9 p. ct.; sp. gr. 0.866, color dark red; 357°–372° C., 38.1 p. ct.; sp. gr. 0.867, color opaque.
745	Twin Creek district	.....	.....	.....	.....	.....	.....	.....	.....	0	.....	.....	.....	.....	.....	277°–344° C., 54 p. ct.; sp. gr. 0.881; flash point, 62° C.; burning point, 97°. C.
	Weston County.															
746	Newcastle; near B. & M. Rwy.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Fractionally distilled into 10 portions; 107°–267° C., 267°–319° C., 319°–355° C., 355°–372° C.. 372°–383° C., 383°–389° C., 389°–395° C., 395°–407° C. Contains paraffin.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	WYOMING—continued.								
	Weston County—Continued.								
747	Newcastle		American spring			0.9200	22.2	Red-brown by transmitted light.	
748	Do		Middle spring			.9160	22.8	Red-brown by transmitted light, opaque and viscous.	
749	Do		Eagle spring			.9168	22.7	....do	

747–749. Wyoming Univ. Bull. 5, E. E. Slosson, analyst.

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Analyses of petroleum from various parts of the United States—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.							
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.					Crude	150°–300°C.	
	WYOMING—continued.															
	Weston County—Continued.															
747	Newcastle															Fractionally distilled into 10 portions: 107°–303° C., 303°–319° C., 319°–353° C., 353–367° C., 367°–374° C., 374°–375° C., 375°–377° C., 377°–379° C., 379°–382° C., 382°–392° C. Contains paraffin.
748	Do															Fractionally distilled: 117°–277° C., 277°–327° C., 327°–353° C., 353°–367° C., 367°–375° C., 375°–382° C., 382°–394° C. Contains paraffin.
749	Do															Burning point, 153° C. Fractionally distilled 20 portions, sp. gr. of first 8 fractions as follows: 0.868, 0.874, 0.881, 0.888, 0.892, 0.897, 0.897, 0.897; color light yellow. Viscosity by Engler method at 15.5° C., 29.43.

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Analyses of petroleum from other countries.

Serial No.	Location of well.	Collected by—	Collected from—	Well.	Depth of well (feet).	Physical properties.			
						Gravity at 60°F.		Color.	Odor.
						Specific.	Baumé.		
	MEXICO.								
	Vera Cruz Province.								
750	Topila	W. S. Cummins	Well	Sharp, No. 1	2,300	0.7839	48.6		Aromatic.
	NEW ZEALAND.								
	Gisbourne district.								
751	Gisbourne	W. L. Clayton	Well	1	655	.8642	32.0	Green	
	Tavanak district.								
752	Gisbourne	W. L. Clayton	Well	2		.8495	34.8	Brown	
	PHILIPPINE ISLANDS.								
	Province of Tayabos.								
753	East coast of Tayabos	O. A. Leary			a120	.8318	38.3	Claret	
	SPAIN.								
	Province of Cadiz.								
754	Near Villa Martin	U. S. consulate at Seville.	Well		312	.7973	45.6	Light amber	
755	Do	do	do		275	.8018	44.6	do	

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Analyses of petroleum from other countries—Continued.

Serial No.	Location of well.	Distillation by Engler's method.								Sulphur (per cent).	Paraffin (per cent).	Asphalt (per cent).	Water (per cent).	Unsaturated hydrocarbons (per cent).		Remarks.
		Begins to distill at (°C.)	By volume.													
			To 150° C.		150°–300° C.		Residuum.		Total.					Crude	150°–300°C.	
			Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.							
	MEXICO.															
	Vera Cruz Province.															
750	Topila	155	.....	.....	98.0	0.7829	2.4	.....	100.4	(a)	Tr.	0	0	.....	.....	a Not determined.
	NEW ZEALAND.															
	Gisbourne district.															
751	Gisbourne	210	.....	.....	43.0	.7300	57.1	0.8923	100.1	.....	8.88	.....	Some.	16.4	7.0	Gray sandstone.
	Tavanak district.															
752	Gisbourne	97	10.0	0.7805	50.0	.8281	39.9	.8969	99.9	.....	14.78	.....	Some.	24.4	2.9	
	PHILIPPINE ISLANDS.															
	Province of Tayabos.															
753	East coast of Tayabos	100	18.0	.7698	58.0	.8304	23.5	.9498	99.5	.....	.....	.....	.....	15.2	9.0	a Below surface of well.
	SPAIN.															
	Province of Cadiz.															
754	Near Villa Martin	87	27.5	.7375	53.0	.8088	18.4	.8727	98.9	0	2.52	.....	.....	5.6	5.0	
755	Do	108	19.0	.7414	60.0	.8000	21.0	.8708	100.0	0	3.20	.....	.....	7.6	7.0	

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UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS, 1901–1913, ON THE OIL FIELDS OF THE UNITED STATES.

The following publications of the United States Geological Survey refer to the oil fields of the United States; the later papers supplement the general description of the oil and gas fields given in these reports for 1907 and 1908:

ANNUAL REPORTS.

[a] Eighth Annual Report of the United States Geological Survey, 1886–87, J. W. Powell, Director, 1889.
Pt. II, pp. 475–1063, pls. liv–lxii. $1.50.
The Trenton limestone as a source of petroleum and inflammable gas in Ohio and Indiana, by Edward Orton, pp. 475–662, pls. liv–lx.

Eleventh Annual Report of the United States Geological Survey, 1889–90, J. W. Powell, Director, 1891.
Pt. I. Geology, 757 pp., 66 pls.
The natural gas field of Indiana, by Arthur John Phinney, pp. 587–742, pls. lxii–lxvi.

[a] Nineteenth Annual Report of the United States Geological Survey, 1897–98, Charles D. Walcott, Director.
Pt. II. Papers chiefly of a theoretic nature, v, 958 pp., 172 pls., 1899. $2.65.
The Cretaceous formation of the Black Hills as indicated by the fossil plants, by L. F. Ward with the collaboration of W. P. Jenney, W. M. Fontaine, and F. H. Knowlton, pp. 521–946, pls. liii–clxxii.

[a] Twenty-second Annual Report of the United States Geological Survey, 1900–1901, Charles D. Walcott, Director, 1901.
Pt. III. Coal, oil, cement, 763 pp., 53 pls. $2.00.
The Gaines oil field of northern Pennsylvania, by M. L. Fuller, pp. 573–627, pls. xxxvi–xliii.

PROFESSIONAL PAPERS.

[a] 53. Geology and water resources of the Bighorn Basin, Wyoming, by C. A. Fisher, 72 pp., 16 pls., 1907. 60c.

[a] 56. Geography and geology of a portion of southwestern Wyoming, with special reference to coal and oil, by A. C. Veatch. 178 pp., 26 pls., 1907. 60c.

65. Geology and water resources of the northern portion of the Black Hills and adjoining regions in South Dakota and Wyoming, by N. H. Darton. 105 pp. 24 pls., 1909.

BULLETINS.

[a] 128. The Bear River formation and its characteristic fauna, by C. A. White. 108 pp., 11 pls., 1895. 15c.

184. Oil and gas fields of the western interior and northern Texas coal measures and of the Upper Cretaceous and Tertiary of the western Gulf coast, by George I. Adams. 64 pp. 10 pls., 1901. 30c.

[a] 198. The Berea grit oil sand in the Cadiz quadrangle, Ohio, by W. T. Griswold. 43 pp., 1 pl., 1902. 10c.

212. Oil fields of the Texas-Louisiana Gulf Coastal Plain, by C. W. Hayes and William Kennedy. 174 pp., 11 pls., 1903. 20c.

[a] 213. Contributions to economic geology, 1902; S. F. Emmons and C. W. Hayes, geologists in charge. 449 pp., 1903. 25c.
The petroleum fields of California, by George H. Eldridge, p. 306.
The Boulder, Colo., oil field, by N. M. Fenneman, p. 322.
Asphalt, oil, and gas in southwestern Indiana, by Myron L. Fuller, p. 333.
Structural work during 1901 and 1902 in the eastern Ohio oil fields, by W. T. Griswold, p. 336.
Oil fields of the Texas-Louisiana Gulf Coastal Plain, by C. W. Hayes, p. 345.

[a] Geological Survey's stock of the paper is exhausted, but many of the papers marked in this way may be purchased from the Superintendent of Documents, Washington, D. C., at the prices indicated.

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[a] 225. Contributions to economic geology, 1903; S. F. Emmons and C. W. Hayes, geologists in charge. 527 pp., 1 pl., 1904. 35c.
Petroleum fields of Alaska and the Bering River coal fields, by G. C. Martin, p. 365.
Structure of the Boulder oil field, Colorado, with records for the year 1903, by N. M. Fenneman, p. 383.
The Hyner gas pool, Pennsylvania, by M. L. Fuller, p. 392.
Oil and gas fields of eastern Greene County, Pa., by Ralph W. Stone, p. 396.

238. Economic geology of the Iola quadrangle, Kansas, by G. I. Adams, Erasmus Haworth, and W. R. Crane. 83 pp., 11 pls., 1904. 25c.

250. The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. 64 pp., 7 pls., 1905.

256. Mineral resources of the Elders Ridge quadrangle, Pennsylvania, by R. W. Stone. 86 pp., 12 pls., 1905.

259. Report on progress of investigations of mineral resources of Alaska in 1904, by A. H. Brooks and others. 196 pp., 3 pls., 1905. 15c.

[a] 260. Contributions to economic geology, 1904; by S. F. Emmons and C. W. Hayes, geologists in charge. 620 pp., 4 pls., 1905. Out of print.
The Florence, Colo., oil field, by N. M. Fenneman, p. 436.
Notes on the geology of the Muskogee oil field, Oklahoma, by J. A. Taff and M. K. Shaler, p. 441.
Oil and gas in the Independence quadrangle, Kansas, by F. C. Schrader and Erasmus Haworth, p. 446.
Oil fields of the Texas-Louisiana Gulf coast, by N. M. Fenneman, p. 459.
Oil and asphalt prospects in Salt Lake Basin, Utah, by J. M. Boutwell, p. 468.

264. Record of deep-well drilling for 1904, by M. L. Fuller, E. F. Lines, and A. C. Veatch. 106 pp., 1905. 10c.

265. Geology of the Boulder district, Colorado, by N. M. Fenneman. 101 pp., 5 pls., 1905.

[a] 279. Mineral resources of the Kittanning and Rural Valley quadrangles, Pennsylvania, by Charles Butts. 198 pp., 11 pls., 1906.

[a] 282. Oil fields of the Texas-Louisiana Gulf Coastal Plain, by N. M. Fenneman. 146 pp., 11 pls., 1906. 20c.

[a] 285. Contributions to economic geology, 1905; S. F. Emmons and E. C. Eckel, geologists in charge. 506 pp., 13 pls., 1906. Out of print.
The Salt Lake oil field near Los Angeles, Cal., by Ralph Arnold, p. 357.
The Nineveh and Gordon oil sands in western Greene County, Pa., by F. G. Clapp, p. 362.

286. Economic geology of the Beaver quadrangle, Pennsylvania, by L. H. Woolsey. 132 pp., 8 pls., 1906.

[a] 296. Economic geology of the Independence quadrangle, Kansas, by F. C. Schrader and Erasmus Haworth. 74 pp., 6 pls., 1906.

[a] 298. Record of deep-well drilling for 1905, by Myron L. Fuller and Samuel Sanford. 299 pp., 1906. 25c.

[a] 300. Economic geology of the Amity quadrangle in eastern Washington County, Pa., by F. G. Clapp. 145 pp., 8 pls., 1907.

[a] 304. Oil and gas fields of Greene County, Pa., by R. W. Stone and F. G. Clapp. 110 pp., 3 pls., 1907. 45c.

[a] 309. The Santa Clara Valley, Puente Hills, and Los Angeles oil districts, southern California, by G. H. Eldridge and Ralph Arnold. 266 pp., 41 pls., 1907. 80c.

[a] 314. Report on progress of investigations of mineral resources of Alaska in 1906, by A. H. Brooks and others. 235 pp., 4 pls., 1907. 30c.

[a] 317. Preliminary report on the Santa Maria oil district, Santa Barbara County, Cal., by Ralph Arnold and Robert Anderson. 69 pp., 2 pls., 1907. 15c.

[a] 318. Geology of oil and gas fields in Steubenville, Burgettstown, and Claysville quadrangle, Ohio, West Virginia, and Pennsylvania, by W. T. Griswold and M. J. Munn. 196 pp., 13 pls., 1907. 75c.

[a] 321. Geology and oil resources of the Summerland district, Santa Barbara County, Cal., by Ralph Arnold. 91 pp., 20 pls., 1907. 25c.

[a] 322. Geology and oil resources of the Santa Maria oil district, Santa Barbara County, Cal., by Ralph Arnold and Robert Anderson. 161 pp., 26 pls., 1907. 50c.

[a] Geological Survey's stock of the paper is exhausted, but many of the papers marked in this way may be purchased from the Superintendent of Documents, Washington, D. C., at the prices indicated.

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[a] 335. Geology and mineral resources of the Controller Bay region, Alaska, by G. C. Martin. 141 pp., 10 pls., 1908. 70c.

[a] 340. Contributions to economic geology, 1907, Part I: Metals and nonmetals except fuels. C. W. Hayes, Waldemar Lindgren, geologists in charge. 482 pp., 7 pls., 1908. 30c.

Oklahoma: Northeastern Oklahoma, by C. E. Siebenthal, pp. 210–213. California: Contra Costa County, Miner ranch field, by Ralph Arnold. Utah: Southern Utah oil field, by G. B. Richardson. Wyoming: Bighorn Basin gas fields, by C. W. Washburne; Uinta County, Labarge oil field, by A. R. Schultz, pp. 339–374.

346. Structure of the Berea oil sand in the Flushing quadrangle, Ohio, by W. T. Griswold. 30 pp., 2 pls., 1908.

[a] 350. Geology of the Rangely oil district, Rio Blanco County, Colo., with a section on the water supply, by H. S. Gale. 60 pp., 4 pls., 1908. 20c.

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DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

THE STONE INDUSTRY IN THE UNITED STATES IN 1913

By ERNEST F. BURCHARD

From Mineral Resources of the United States, Calendar Year 1913—Part II
(Pages 1285-1410)

WASHINGTON
GOVERNMENT PRINTING OFFICE
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CONTENTS.

	Page.
Introducttion	1285
Unit of measurement	1287
Production	1286
Granite	1288
Trap rock	1288
Marble	1289
Limestone	1289
Sandstone	1289
Exports and imports	1295
Tariff	1296
Granite	1297
Production	1297
Granite in individual States	1303
Maine	1303
Massachusetts	1305
Minnesota	1305
New Hampshire	1306
Vermont	1308
Wisconsin	1310
Trap rock	1312
Marble	1313
Limestone	1318
Sandstone	1328
Bluestone	1334
Stone resources in the States west of the Rocky Mountains	1335
Quarry maps	1335
Arizona, by E. F. Burchard	1338
Utah, by G. F. Loughlin	1346
California, by G. F. Loughlin	1354
Nevada, by E. F. Burchard	1367
Idaho, by G. F. Loughlin	1376
Oregon, by E. F. Burchard	1387
Washington, by E. F. Burchard	1398
Survey publications on stone, slate, and road metal	1408

ILLUSTRATIONS.

		Page.
PLATE V.	Map showing location of stone quarries in Arizona and Utah	1338
VI.	Map showing location of stone quarries in California and Nevada	1354
VII.	Map showing location of stone quarries in Idaho, Oregon, and Washington	1376

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STONE.

By ERNEST F. BURCHARD.

INTRODUCTION.

The present report on the stone industry contains, in addition to the usual large amount of statistical data on the production of the various commercial types of stone, subdivided into the several forms in which the stone is marketed, the completion of the general discussion of the stone resources of the United States which was begun in the report for 1911. The report for 1911 dealt with the stone quarried in the States east of Mississippi River and was illustrated by seven maps showing the location of the stone quarries by the types of stone. The report for 1912 was illustrated by six maps and was concerned with the 15 Middle States west of the Mississippi. The present chapter covers the stone resources of the States west of the Rocky Mountains, including Arizona, California, Idaho, Nevada, Oregon, Utah, and Washington, and is illustrated by three quarry maps. The maps and text relating to California, Idaho, and Utah were prepared by G. F. Loughlin, of the U. S. Geological Survey.

The value of the stone output for 1912 showed an increase of 1.4 per cent, with decreases of from 1 to 12 per cent for three of the varieties of stone under which data are grouped and with increases of from 3 to 8 per cent for the other two varieties. The statistics for 1913, however, showed certain increases ranging from 1 to 22 per cent in value, with a total average increase of 7.08 per cent. Of the most important stone products, stone for exterior building and for curbing showed considerable decreases, while the other important products, as monumental stone, paving stone, crushed stone, limestone for flux, riprap, etc., showed increases. It is well known that stone has suffered severe competition for several years past from various types of cheaper structural materials, and a large number of owners of small quarries who were accustomed to quarry stone for foundation and rough rubble work have closed their quarries on account of lack of demand, this stone having been replaced by concrete and brick. The demand for the more expensive grades of building stone has continued fairly regular, and the decrease caused by the closing of quarries furnishing the cheaper stone has been offset in the grand total by the increase in the output of crushed stone, which at one time was considered only a by-product.

The stone industry outside of regular quarry centers shows great irregularity in its fluctuations, being influenced largely by local demand. Construction of seawalls, river improvement work, ballasting of railroad tracks, construction of roads, reservoirs, and dams, repairing and constructing locks on canals, and other similar structural work may call for the opening of a quarry in the vicinity of

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the work, and for the abandonment of this quarry as soon as the work is completed. This naturally causes a large increase and corresponding decrease in the output of those States where there is no regularly defined quarry region, and even in States having regular quarry centers a contract for a large public building or any extra construction work influences the output of the region.

In the statistical part of this report, which is entirely the work of Miss A. T. Coons, of the United States Geological Survey, new tables are added nearly every year which give not only the value of the stone production but the quantity of stone quarried as well, and it is hoped in this way to increase the value of the statistics from year to year by the inclusion of quantitative data. This improvement is hindered by the lack of uniform units of measurement in the reports of the quarrymen and in many cases by their omission of any quantities whatever.

The figures presented in the following report, as in previous years, have to do with the stone produced and sold, or used by the quarrymen, and include only such manufactured product as is put on the market by the quarrymen themselves. This applies especially to rough and dressed building stone, rough and dressed monumental stone, crushed stone, flagstone, curbstone, and paving blocks. The value given to the manufactured product is the price received by the producer free on board at point of shipment, and includes, therefore, the cost of labor necessary to dress the stone. The stone reported as sold rough includes stone sold as rough stock to monumental works and to cut-stone contractors for building purposes and stone sold as riprap, rubble, and flux; the value includes the cost of only such labor as is required to get the stone out of the quarry in the shape required by the purchaser. The value given to this stone is the price received by the quarryman free on board at point of shipment. In case the stone is sold to local trade the value is given as the quarryman sells the material, generally at the quarry, but in some cases delivered, if this is done by the producer. In some places a long haul to market or to the railroad increases the cost of the material and therefore the selling price.

For simplicity of treatment the kinds of stone covered by the statistics in this report are classified as granite, trap rock, marble, limestone, and sandstone.

Granite includes true granite as well as monzonite, syenite, gneiss, and schist, and certain other crystalline rocks which are quarried by too few producers to permit their production to be shown separately. The varieties of crystalline rocks thus occasionally included under "granite" are mostly of the light volcanic type, such as tuff, rhyolite, trachyte, and andesite, but from time to time small quantities of dark crystalline and volcanic rocks, such as basalt, diorite, diabase, gabbro, and dolerite, are necessarily included with granite. The trap rock output for California, Hawaii, Massachusetts, New York, New Jersey, Oregon, Pennsylvania, and Washington represents an important industry, and it is therefore possible to show the value of this stone separately. The trap rock from these States consists largely of basalt. The separation of basalt in Oregon and Washington from granite is made for the first time in this report. In order to make the figures for 1912 comparable they have been changed for these States to conform with the 1913 figures. In the discussion of the stone resources of the States west of the Rocky Mountains the

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deposits of granitic rock, dark volcanic rocks, and light volcanic rocks have been considered separately, and the quarries in these three classes of rocks are indicated by distinctive symbols.

Marble includes a small quantity of serpentine quarried and sold as marble in California, Georgia, Maryland, Pennsylvania, and Vermont, and also a small quantity of the so-called "onyx" marble or travertine obtained from caves and other deposits in Kentucky and other States.

Limestone does not include limestone burned into lime, bituminous limestone, nor limestone entering into the manufacture of Portland cement. It includes, however, a small quantity of stone sold locally as marble.

Sandstone includes the quartzites of South Dakota, Minnesota, and Wisconsin and the fine-grained sandstones of New York and Pennsylvania, known to trade as bluestone. As bluestone is the product of a distinct local industry, its production is also shown separately from that of the other sandstones. Bluestone is also quarried in New Jersey and West Virginia, but this product is small and is not separated from sandstone. In Kentucky most of the sandstone quarried and sold is known locally as freestone. The figures given for sandstone do not include the value of the grindstones, whetstones, and pulpstones made from sandstones quarried in Michigan, Ohio, and West Virginia; nor does the total sandstone value include sandstone crushed into sand and used in the manufacture of glass and as molding sand. The production of these materials is published in other reports in Mineral Resources.

UNIT OF MEASUREMENT.

Owing to the variety of uses to which stone is put, there is no regular unit of measurement employed by the quarrymen, the stone being sold by the cubic yard, the cubic foot, the ton, cord, perch, rod, square foot, square yard, square, etc. Building and monumental stone, especially the dressed product, is usually sold by the cubic foot or the cubic yard, although this unit varies with the class of stone and with the locality; a large quantity of the rough stone is sold by the perch, cord, and ton. Rubble and riprap, including stone for such heavy masonry as breakwater and jetty work, are generally sold by the cord and ton. Fluxing stone and stone for chemical use—as for alkali works, sugar factories, carbonic-acid plants, paper mills—are sold by the long ton. Flagstone and curbstone are sold by the square yard and the square foot, the thickness being variable and dependent on the orders received. Granite paving blocks are sold invariably by number of blocks, and as such have been tabulated and published for several years; these blocks, however, are not of uniform size, the value depending on the size and the labor necessary to cut the block into the shape desired. Other paving material is sold by various units, as ton, cubic yard, etc. Crushed stone is reported as sold by the cubic yard or ton, the short ton being more generally used. The weight of a cubic yard of crushed stone varies from 2,300 to 3,000 pounds, the average weight being about 2,500 pounds. In certain localities this crushed stone is sold by the "square" of 100 square feet by 1 foot, or 100 cubic feet to a square. It is also of interest to note the selling of crushed stone by the bushel, 21½ bushels representing a cubic yard of about 2,700 pounds. As

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most of the crushed-stone producers report the quantity according to some unit, it has been possible to convert the crushed stone into short tons, which unit represents the larger number of producers and is the most convenient.

On the statistical inquiry cards asking for the production of stone according to various stone products, the producers do not always report the quantity, but it has been possible to publish in this report the quantity as well as the value of the granite production of Maine, New Hampshire, Minnesota, Vermont, and Wisconsin. The value of the granite production of Massachusetts is given for the first time by counties and uses, although it was found impossible to give the figures of quantity. The report includes also the limestone production in the Bedford, Ind.; Carthage, Mo.; and Bowling Green, Ky., limestone districts; the marble production of California, Georgia, Massachusetts, New York, Tennessee, and Vermont; and the quantity of the total marble output.

PRODUCTION.

The total value of the stone produced in the United States in 1913 was $83,732,995, as compared with $78,193,220 in 1912, an increase of $5,539,775, or 7.08 per cent. The year surpassed all previous years in the value of its stone output, the value of granite, trap rock, sandstone, marble, and limestone increasing 8.17, 22.88, 2.02, 1.08, and 5.49 per cent, respectively, over the value for 1912.

The following table shows the value of the different kinds of stone produced in the United States from 1901 to 1913, inclusive:

Value of the different kinds of stone produced in the United States, 1901–1913.

Year.	Granite.	Trap rock.	Sandstone.[a]	Marble.	Limestone.	Total.
1901	$14,266,104	$1,710,857	$8,138,680	$4,965,699	$18,202,843	$47,284,183
1902	16,083,475	2,181,157	10,594,483	5,044,182	20,895,385	54,798,682
1903	15,703,793	2,732,294	11,282,259	5,362,686	22,372,109	57,433,141
1904	17,191,479	2,823,546	10,273,991	6,297,835	22,178,964	58,765,715
1905	17,563,139	3,074,554	10,006,774	7,129,071	26,025,210	63,798,748
1906	18,562,806	3,736,571	9,109,837	7,582,938	27,327,142	66,378,794
1907	18,064,708	4,594,103	8,871,078	7,837,585	31,737,631	71,105,805
1908	18,420,080	4,282,406	7,594,091	7,733,920	27,682,002	65,712,499
1909	19,581,597	5,133,842	8,010,454	6,548,905	32,070,401	71,345,199
1910	20,541,967	6,452,141	7,930,019	6,992,779	34,603,678	76,520,584
1911	21,194,228	6,739,141	7,730,968	7,546,718	33,897,612	77,108,567
1912	19,223,302	7,560,049	6,893,611	7,786,458	36,729,800	78,193,220
1913	20,793,800	9,289,809	7,033,067	7,870,890	38,745,429	83,732,995
Percentage of increase (+) or decrease (−) for 1913	+8.17	+22.88	+2.02	+1.08	+5.49	+7.08
Percentage of total	24.83	11.10	8.40	9.40	46.27	100.00

[a] Includes bluestone.

The foregoing table shows the following relations between the values of the various classes of rock and the changes that occurred in the totals from 1912 to 1913:

Granite.—The value of granite represented 24.83 per cent of the total value of stone for 1913. The increase in value was $1,570,498, from $19,223,302 in 1912 to $20,793,800 in 1913, or 8.17 per cent. Granite for building, monumental, crushed stone, paving blocks, riprap, and rubble increased in value, but there was a decrease in the value of granite for curbing and flagging.

Trap rock.—Trap rock showed the largest increase, $1,729,760, of all the varieties of stone, from $7,560,049 in 1912 to $9,289,809 in 1913, or 22.88 per cent. The trap rock output is chiefly crushed stone.

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Marble.—Marble represented 9.40 per cent of the total stone value in 1913 and increased from $7,786,458 in 1912 to $7,870,890 in 1913, a gain of $84,432, or 1.08 per cent.

Limestone.—The value of limestone represented 46.27 per cent of the total value of stone produced in 1913. It increased from $36,729,800 in 1912 to $38,745,429 in 1913, a gain of $2,015,629, or 5.49 per cent.

Sandstone.—Sandstone, including quartzite, and bluestone increased in value from $6,893,611 in 1912 to $7,033,067 in 1913, a gain of $139,456, or 2.02 per cent.

The value of bluestone, included with standstone, decreased from $1,505,763 in 1912 to $1,280,862 in 1913, a decrease of $224,901, or 14.9 per cent.

The following table shows the rank of States and Territories in 1912 and 1913, according to value of production of stone, and the percentage of the total produced by each State or Territory.

Rank of States and Territories in 1912 and 1913, according to value of production of stone, and percentage of total produced by each State or Territory.

1912.

Rank of State.	State or Territory.	Total value.	Percentage of total.	Number of plants.
1	Pennsylvania	$9,144,214	11.69	700
2	Vermont	6,554,851	8.38	56
3	New York	6,415,015	8.20	255
4	Ohio	6,197,388	7.92	245
5	Indiana	5,091,924	6.51	131
6	California	3,902,313	4.99	150
7	Illinois	3,841,504	4.91	106
8	Massachusetts	3,663,279	4.68	137
9	Missouri	2,486,505	3.18	194
10	Wisconsin	2,211,347	2.83	186
11	Georgia	1,983,016	2.54	42
12	Minnesota	1,845,746	2.36	74
13	Maine	1,810,590	2.31	79
14	New Jersey	1,716,829	2.19	102
15	Tennessee	1,656,812	2.12	85
16	Connecticut	1,467,458	1.88	65
17	Colorado	1,420,007	1.82	47
18	New Hampshire	1,311,488	1.68	36
19	Kentucky	1,282,148	1.64	100
20	Michigan	1,192,204	1.52	62
21	Washington	1,174,047	1.50	32
22	West Virginia	1,164,877	1.49	70
23	Maryland	1,054,872	1.35	42
24	North Carolina	1,032,022	1.32	67
25	Iowa	946,436	1.21	95
26	Virginia	877,746	1.12	63
27	Alabama	842,300	1.08	26
28	Rhode Island	768,067	.98	19
29	Kansas	763,228	.98	97
30	Texas	680,365	.87	37
31	Arkansas	513,344	.66	20
32	Oklahoma	429,788	.55	32
33	Nebraska	336,189	.43	13
34	New Mexico	335,937	.43	7
35	Oregon	268,002	.34	22
36	South Carolina	263,905	.34	13
37	Utah	249,782	.32	27
38	Hawaii	231,351	.30	9
39	Montana	216,079	.28	18
40	Delaware	193,074	.25	5
41	South Dakota	162,295	.21	21
42	Alaska	(a)	.....	.....
43	Florida	(a)	.....	.....
44	Wyoming	68,479	.09	10
45	Arizona	67,124	.09	18
46	Idaho	63,974	.08	11
47	Louisiana	(a)	.....	.....
48	Nevada	(a)	.....	.....
	Other States	b 293,699	.38	11
	Total	78,193,220	100.00	3,687

a Included in "Other States." b Includes Alaska, Florida, Louisiana, and Nevada.

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Rank of States and Territories in 1912 and 1913, according to value of production of stone, and percentage of total produced by each State or Territory—Continued.

1913.

Rank of State.	State or Territory.	Total value.	Percentage of total.	Number of plants.
1	Pennsylvania	$10,117,469	12.08	624
2	Vermont	7,313,355	8.73	57
3	New York	7,185,493	8.58	189
4	Ohio	6,261,338	7.48	234
5	Indiana	4,676,689	5.58	127
6	Illinois	4,140,953	4.94	109
7	California	4,118,935	4.92	150
8	Massachusetts	4,096,372	4.89	138
9	Missouri	2,538,699	3.03	179
10	Wisconsin	2,157,980	2.58	198
11	Georgia	2,105,366	2.51	36
12	Tennessee	2,062,686	2.46	76
13	Minnesota	1,953,686	2.33	93
14	Maine	1,792,079	2.14	71
15	New Jersey	1,772,832	2.12	90
16	Connecticut	1,603,663	1.91	65
17	Michigan	1,520,133	1.82	35
18	New Hampshire	1,482,771	1.77	36
19	Washington	1,399,475	1.67	36
20	Alabama	1,285,944	1.54	35
21	North Carolina	1,212,501	1.45	37
22	West Virginia	1,193,323	1.43	64
23	Maryland	1,153,115	1.38	63
24	Kentucky	1,150,205	1.37	92
25	Virginia	1,063,782	1.27	77
26	Colorado	985,817	1.18	52
27	Kansas	825,607	.99	84
28	Iowa	805,294	.96	83
29	Texas	725,106	.87	39
30	Rhode Island	643,995	.77	16
31	Arkansas	525,050	.63	17
32	Utah	415,471	.50	20
33	South Carolina	360,476	.43	14
34	Oregon	357,498	.43	24
35	Montana	343,516	.41	17
36	Nebraska	327,187	.39	15
37	Delaware	289,987	.35	6
38	Oklahoma	278,600	.33	25
39	Hawaii	249,390	.30	10
40	New Mexico	219,566	.26	9
41	Florida	207,420	.25	10
42	Alaska	(a)		
43	South Dakota	172,736	.21	19
44	Idaho	152,390	.18	13
45	Wyoming	109,784	.13	7
46	Arizona	107,989	.13	15
47	Louisiana	(a)		
	Other States [b]	272,272	.32	3
	Total	83,732,995	100.00	3,409

[a] Included in "Other States." [b] Includes Alaska and Louisiana.

Pennsylvania has always held first rank among the stone producing States—except in the year 1908 when Vermont reported the largest production—and in 1913 it produced 12.08 per cent of the total of the entire United States, Vermont being second, with 8.73 per cent. Other large stone-producing States following in order of rank of output are New York, Ohio, Indiana, Illinois, California, Massachusetts, Missouri, Wisconsin, Georgia, and Tennessee, each of whose production was valued at more than $2,000,000. In 1912 the leading States were Pennsylvania, Vermont, New York, Ohio, Indiana, California, Illinois, Massachusetts, Missouri, Wisconsin, and Maine. In 1913 Illinois supplanted California, and Georgia and Tennessee went with the States producing more than $2,000,000. Fourteen States in 1912 produced stone valued at between $1,000,000 and $2,000,000, and 13 States in 1913 fell between these limits.

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Of 48 States reporting in 1912, 37 States showed an increased production in 1913 and 10 a decrease. Nevada dropped out in 1913.

The number of active operations in 1913 was 3,409, compared with 3,637 in 1912, a decrease of 228 operations, although the value of the output increased over 7 per cent. A number of causes contributed to this decrease, the chief of which was the tendency of small producers to abandon their quarries on account of lack of demand for foundation stone. Also the high cost and scarcity of labor was a strong factor against the small quarryman. Combination of properties and the regular fluctuations of demand also have considerable influence on the increase or decrease of operations.

The following table shows the value of the stone used for various purposes in 1912 and 1913. Only such values are given as are for uses common to two or more varieties of stone.

Value of granite, trap rock, sandstone, limestone, and marble used for various purposes in 1912 and 1913.

1912.

Kinds.	Building (rough and dressed).	Monumental (rough and dressed).	Flagstone.	Curbstone.	Paving stone.	Crushed stone.
Granite	$6,125,841	$4,643,919	$41,640	$398,209	$2,562,005	$3,465,678
Trap rock	93,988	.....	.....	.....	265,635	6,341,625
Sandstone	2,263,289	.....	721,069	1,106,545	585,275	1,165,634
Limestone	5,051,896	.....	14,393	153,015	278,930	17,619,599
Marble [a]	2,771,645	2,115,200	.....	.....	.....	.....
Total	16,306,659	6,759,119	777,102	2,159,769	3,691,845	28,592,536

1913.

Granite	$6,661,415	$4,715,084	$13,172	$814,290	$2,755,995	$3,850,887
Trap rock	83,078	.....	.....	.....	204,346	7,506,516
Sandstone	1,860,924	.....	553,129	1,154,836	736,767	1,248,244
Limestone	4,509,339	.....	7,337	108,793	239,340	19,072,224
Marble [a]	1,822,458	2,497,564	.....	.....	.....	.....
Total	14,937,214	7,212,648	573,638	2,077,919	3,936,448	31,677,871
Percentage of increase (+) or decrease (−) over 1912.	−8.40	+6.71	−26.18	−3.94	+6.63	+10.79

[a] Marble for exterior building only.

This table, besides showing the comparative value of the different varieties of stone according to their common usage, shows the changes for the total output with respect to the different stone products.

A comparison of the figures for 1912 and 1913 shows decrease in the totals for building stone, flagstone, and curbstone, with increase for monumental, paving, and crushed stone.

Building stone decreased in value from $16,306,659 in 1912 to $14,937,214 in 1913, a loss of $1,369,445, or 8.4 per cent. The only increase shown was in the granite production.

Monumental stone increased in value $453,529, or 6.71 per cent. Marble and granite are the only varieties of stone representing this product, although a small quantity of limestone is used for this work, and an inconsiderable quantity of sandstone is reported as sold locally for tombstone bases. The total output was valued at $7,212,648 in 1913, as compared with $6,759,119 in 1912.

Flagstone decreased $203,464, or 26.18 per cent, in 1913. The decrease was general for all kinds of stone, but sandstone, which in-

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cluded chiefly the bluestone of Pennsylvania and New York, showed the largest decrease. The use of concrete for this purpose instead of stone is the principal cause of the loss.

Curbstone decreased in value $81,850, or 3.94 per cent, from $2,159,769 in 1912 to $2,077,919 in 1913.

Stone for paving increased in value from $3,691,845 in 1912 to $3,936,448 in 1913, a gain of $244,603, or 6.63 per cent. Limestone and trap rock showed a slight decrease, which was more than balanced by the increase in granite and sandstone.

Crushed stone, which is the largest product common to more than one variety of stone, showed the largest increase in value—from $28,592,536 in 1912 to $31,677,871 in 1913, a gain of $3,085,335, or 10.79 per cent.

The following table shows the quantity and value of crushed stone produced in the United States in 1912 and 1913, by uses and kinds of stone:

Quantity and value of crushed stone produced in the United States in 1912 and 1913 by uses and by kinds of stone, in short tons.

1912.

Kind.	Road making.		Railroad ballast.		Concrete.		Total.		Average price per ton.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
Granite	1,558,893	$1,218,108	1,360,985	$797,854	1,689,127	$1,449,716	4,609,005	$3,465,678	$0.75
Trap rock	3,910,817	2,868,093	1,755,066	1,012,943	3,536,951	2,460,584	9,202,834	6,341,625	.69
Limestone	13,292,935	7,130,843	10,560,779	4,854,301	9,268,928	5,634,455	33,122,642	17,619,599	.53
Sandstone	477,780	281,414	313,515	170,646	776,725	713,574	1,568,020	1,165,634	.74
Total	19,240,425	11,498,458	13,990,345	6,835,749	15,271,731	10,258,329	48,502,501	28,592,536	
Average price per ton		$0.60		$0.49		$0.67		$0.59	

1913.

Granite	1,800,687	$1,552,062	1,176,879	$743,642	1,904,858	$1,555,183	4,882,424	$3,850,887	$0.79
Trap rock	5,033,071	3,662,834	2,182,987	1,408,954	3,469,959	2,434,728	10,686,017	7,506,516	.70
Limestone	13,296,377	7,353,666	11,774,121	5,551,415	10,099,030	6,167,144	35,169,528	19,072,224	.54
Sandstone	398,806	300,442	311,585	186,043	870,605	761,759	1,580,996	1,248,244	.79
Total	20,528,941	12,869,003	15,445,572	7,890,054	16,344,452	10,918,814	52,318,965	31,677,871	
Average price per ton		$0.63		$0.51		$0.67		$0.61	
Percentage of increase (+) compared with 1912	+6.70	+11.92	+10.40	+15.42	+7.02	+6.44	+7.87	+10.79	

As shown by this table, the quantity and value of the crushed-stone output in 1913 was 52,318,965 short tons, valued at $31,677,871, as compared with 48,502,501 short tons, valued at $28,592,536, in 1912, an increase of 3,816,464 tons, or 7.87 per cent, in quantity and of $3,085,335 in value. The average price per ton was 59 cents for 1912 and 61 cents for 1913.

Crushed granite decreased 273,419 short tons in quantity and $385,209 in value. The average price per ton increased from 75 cents in 1912 to 79 cents in 1913.

Crushed trap rock increased 1,483,183 short tons in quantity and $1,164,891 in value. The average price per ton was reported as 70 cents in 1913 compared with 69 cents in 1912.

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Crushed limestone increased 2,046,886 short tons in quantity and $1,452,625 in value. The average price per ton increased from 53 cents in 1912 to 54 cents in 1913.

Crushed sandstone increased 12,976 short tons in quantity and $82,610 in value. The average price per ton increased from 74 cents in 1912 to 79 cents in 1913.

Crushed stone used for road making increased 1,288,516 short tons in quantity and $1,370,545 in value. The average price per ton 63 cents in 1913, compared with 60 cents in 1912.

Crushed stone for railroad ballast increased 1,455,227 short tons in quantity and $1,054,305 in value. The average price per ton increase from 49 cents in 1912 to 51 cents in 1913.

Crushed stone for concrete increased 1,072,721 short tons in quantity and $660,485 in value. The average price per ton was the same as for 1912, 67 cents.

The following table shows the quantity and value of crushed stone produced in the United States in 1912 and 1913, by States and Territories and by uses:

Production of crushed stone in 1912 and 1913, by States and Territories and by uses, in short tons.

1912.

State or Territory.	Road making.		Railroad ballast.		Concrete.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	85,754	$54,270	30,298	$14,093	65,144	$38,235	181,196	$106,589
Arizona	1,875	2,250	14,950	13,000	11,703	20,956	28,528	36,206
Arkansas	129,577	104,258	177,295	115,725	125,236	107,605	432,108	327,588
California	1,451,487	964,300	948,046	548,578	1,157,665	808,847	3,557,198	2,321,725
Colorado	14,860	15,350	1,222	376	2,945	3,149	19,027	18,875
Connecticut	441,828	288,548	211,460	89,645	314,605	194,119	967,893	572,312
Delaware	80,614	27,861	20,100	14,070	29,533	24,536	80,247	66,467
Florida	84,224	57,836	43,500	15,000	23,514	25,646	151,238	98,482
Georgia	35,621	33,927	42,695	53,223	206,818	199,754	285,134	286,904
Hawaii	105,147	128,854	.....	.....	75,595	94,140	180,742	222,994
Idaho	14,978	10,121	25,000	16,000	5,750	4,600	45,728	30,731
Illinois	2,643,251	1,083,803	960,602	368,349	2,035,113	963,617	5,638,966	2,415,769
Indiana	1,771,521	1,033,673	286,186	102,841	72,603	45,197	2,130,310	1,181,711
Iowa	87,567	30,821	601,137	235,326	422,332	404,877	1,061,036	671,024
Kansas	126,078	95,642	560,322	274,176	317,112	234,261	1,003,512	604,079
Kentucky	514,124	319,057	1,024,538	473,023	200,209	109,355	1,738,871	901,435
Louisiana	10,197	8,158	15,351	12,281	47,776	38,221	73,324	58,660
Maine	7,090	5,062	18,666	14,000	6,627	5,075	32,383	24,137
Maryland	359,921	295,726	383,371	212,879	144,634	133,674	887,926	642,279
Massachusetts	460,564	431,162	14,651	13,985	934,432	741,835	1,409,647	1,186,982
Michigan	625,358	313,815	54,327	28,368	196,778	106,638	876,463	448,821
Minnesota	76,783	65,952	59,905	40,642	328,445	287,600	465,133	394,194
Missouri	333,591	262,438	599,799	387,449	837,096	674,986	1,770,486	1,324,873
Montana	4,141	1,365	184	101	30,593	18,115	34,918	19,581
Nebraska	40	20	9,037	5,985	275,430	252,063	284,507	258,068
New Hampshire	5,270	2,575	2,022	2,527	24,178	20,228	31,470	25,630
New Jersey	855,537	679,768	417,482	266,136	515,311	395,142	1,788,330	1,341,046
New Mexico	.....	.....	710,149	326,022	15,325	7,950	725,474	333,972
New York	1,978,666	1,256,354	1,441,326	742,156	2,333,612	1,466,316	5,753,604	3,464,826
North Carolina	76,746	70,985	116,664	33,254	209,265	206,579	402,675	310,818
Ohio	3,595,221	1,675,300	2,093,441	787,486	600,729	305,267	6,289,391	2,768,053
Oklahoma	89,413	60,862	340,936	178,440	183,680	111,435	614,029	350,737
Oregon	150,587	128,272	28,028	14,636	176,070	102,013	354,685	244,921
Pennsylvania	1,506,457	948,364	1,249,713	723,476	1,205,257	754,231	3,961,427	2,426,071
Rhode Island	58,577	64,777	.....	.....	19,508	24,140	78,085	88,917
South Carolina	40,719	41,252	22,926	21,234	68,035	67,878	131,680	130,364
South Dakota	3,875	4,160	.....	.....	67,671	54,598	71,546	58,758
Tennessee	325,964	268,509	267,267	114,011	214,007	127,076	807,238	509,596
Texas	79,694	52,753	110,212	49,956	633,301	434,332	823,207	537,041
Vermont	2,700	1,975	5,000	2,000	21,396	15,007	29,096	18,982
Virginia	140,697	112,496	300,240	166,856	222,684	156,889	663,621	436,241
Washington	166,926	96,775	5,645	2,847	40,659	29,591	213,230	129,213
West Virginia	40,938	27,440	700,669	328,571	234,883	100,855	976,490	457,166
Wisconsin	755,795	370,559	75,983	26,726	612,741	335,568	1,444,519	732,853
Wyoming	452	703	.....	.....	5,731	6,133	6,183	6,836
Total	19,240,425	11,498,458	13,990,345	6,835,749	15,271,731	10,258,329	48,502,501	28,592,536

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Production of crushed stone in 1912 and 1913, by States and Territories and by uses, in short tons—Continued.

1913.

State or Territory.	Road making.		Railroad ballast.		Concrete.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Alabama	88,330	$47,237	14,633	$7,187	395,727	$255,695	498,690	$310,119
Arizona			1,200	265	7,169	5,735	8,369	6,000
Arkansas	207,110	177,476	103,879	74,961	98,303	80,051	409,292	332,488
California	1,409,976	853,990	845,641	514,120	1,185,017	763,627	3,440,634	2,131,737
Colorado	24,450	33,000			612	522	25,062	33,522
Connecticut	578,547	366,306	95,518	55,694	495,481	304,534	1,169,546	726,534
Delaware	39,837	37,522	30,467	21,327	12,552	10,496	82,856	69,345
Florida	34,664	32,632	96,882	40,006	152,286	117,874	283,832	190,512
Georgia	60,569	49,950	57,466	55,884	134,938	115,959	252,973	221,793
Hawaii	103,542	97,826	24,793	25,747	50,147	52,851	178,482	176,424
Idaho	7,858	15,043	110,250	70,560	18,000	27,000	136,108	112,603
Illinois	1,958,482	921,340	1,405,688	592,210	2,376,700	1,246,042	5,740,870	2,759,592
Indiana	1,736,744	956,284	514,745	203,431	53,876	29,985	2,305,365	1,189,700
Iowa	136,848	81,351	513,531	218,573	464,280	301,305	1,114,659	601,229
Kansas	64,130	49,074	511,370	283,435	350,799	264,854	926,299	597,363
Kentucky	468,135	286,407	995,908	422,864	201,498	104,615	1,665,541	813,886
Louisiana	9,733	7,787	22,455	17,964	50,030	40,240	82,218	65,991
Maine	2,745	2,055	432	324	18,852	16,262	22,029	18,641
Maryland	417,807	373,904	408,507	230,687	213,699	178,065	1,040,013	782,656
Massachusetts	952,707	794,415	112,944	71,882	940,691	824,320	2,006,342	1,690,617
Michigan	557,231	289,685	124,330	56,892	301,612	154,705	983,173	501,282
Minnesota	74,070	64,920	53,816	32,374	504,714	408,467	632,600	505,761
Missouri	488,325	342,849	605,441	405,665	779,846	636,148	1,873,612	1,384,662
Montana	11,410	2,812	1,307	485	27,306	14,480	40,023	17,777
Nebraska			68,938	38,178	275,693	231,626	344,631	269,804
New Hampshire	8,276	6,415	129	129	11,900	10,297	20,305	16,841
New Jersey	916,679	735,926	468,891	317,744	445,437	346,387	1,831,007	1,400,057
New Mexico			384,561	148,016	54,000	54,000	438,561	202,016
New York	2,674,209	1,608,083	1,768,306	951,672	2,372,771	1,509,244	6,815,286	4,068,999
North Carolina	77,071	73,062	137,331	67,828	242,316	235,887	456,718	376,777
Ohio	3,230,300	1,598,434	2,036,173	806,590	692,450	357,568	5,958,923	2,762,592
Oklahoma	5,171	4,384	208,021	98,134	121,316	77,702	334,508	180,220
Oregon	248,423	182,471	113,468	59,873	130,340	83,524	492,231	325,868
Pennsylvania	2,039,553	1,510,849	1,574,561	1,015,796	1,370,611	871,706	4,984,725	3,398,351
Rhode Island	48,500	58,500	1,500	3,000	8,660	7,996	58,660	69,496
South Carolina	56,989	47,776	60,412	43,950	68,238	61,757	185,699	153,483
South Dakota	2,600	1,670			62,169	48,630	64,769	50,300
Tennessee	298,226	212,004	339,768	142,289	199,678	123,945	837,672	478,238
Texas	244,267	145,747	294,476	132,699	324,156	255,782	862,899	534,228
Vermont	4,275	3,783	1,500	664	22,906	15,942	28,681	20,389
Virginia	207,728	151,395	570,517	291,876	248,751	157,470	1,026,996	600,741
Washington	170,952	122,579	11,706	9,908	9,134	4,508	191,792	137,085
West Virginia	104,752	55,882	588,995	284,364	180,451	90,255	874,198	430,501
Wisconsin	757,720	466,178	165,116	74,717	659,932	408,390	1,582,768	949,285
Wyoming					9,348	12,366	9,348	12,366
Total	20,528,941	12,869,003	15,445,572	7,890,054	16,344,452	10,918,814	52,318,965	31,677,871

According to this table nine States in 1913 produced crushed stone valued at more than $1,000,000, as follows, by rank: New York, Pennsylvania, Ohio, Illinois, California, Massachusetts, New Jersey, Missouri, and Indiana.

Besides the stone reported above as crushed for road making, a large quantity of other material answering practically the same purpose as crushed stone is used in construction of roads. In almost all the States a large quantity of gravel, often crushed gravel, is used for road material. In Missouri a considerable amount of road material is obtained from the tailings of the concentrating mills at the zinc mines. This is put on the market as "chats" and consists of small angular fragments of chert and limestone. The zinc companies are very glad to get rid of this waste material, which is loaded on the cars by the various railroads of the district at a cost of about 6 or 8 cents a ton. It makes more than ordinarily good roads and is widely distributed all through the Middle West, and sells at prices

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ranging from 50 cents to $1 a ton. In the neighborhood of the mines the material sells for about 15 cents a ton. It is used for railroad ballast as well as road making. The annual output amounts to about 1,300,000 tons. In Tennessee and Alabama a quantity of chert is used for road metal, and crushed slag from the blast furnaces of the various States furnishes a valuable road material. In Alabama, one of the large iron-producing States, over 2,000,000 short tons of furnace slag was crushed and put on the roads, the average value of which was about 25 cents a ton. Crushed slag is also used as railroad ballast and for concrete and roofing material.

Crushed stone is the largest factor in the stone industry at the present time. In 1898 the first figures of the value of crushed stone were published and amounted to $4,031,445. Crushed stone, chiefly for road making and railroad ballast, was reported previously to that time, but was not separated from other products. The growth of the crushed-stone industry is well shown in the following table, which gives the output of exterior building stone, monumental stone, and crushed stone, from 1900 to 1913, the year 1900 being the first year for which exactly comparable tables are available. Prior to the advent of crushed stone, building and monumental stone were considered the chief stone products. The stone crushed for concrete and cement took the place of a large quantity of building and foundation stone.

Value of exterior building stone and of crushed stone, 1900–1913.

Year.	Monumental stone (rough and dressed).	Building stone (rough and dressed).	Crushed stone.	Year.	Monumental stone (rough and dressed).	Building stone (rough and dressed).	Crushed stone.
1900....	$3,618,316	$10,672,598	$6,525,368	1907....	$6,978,949	$16,675,811	$22,054,297
1901....	4,734,699	15,112,600	8,560,432	1908....	6,948,841	16,040,630	20,362,012
1902....	5,941,585	20,790,341	11,480,959	1909....	6,104,190	17,594,455	24,078,780
1903....	5,767,360	19,795,491	13,188,938	1910....	6,887,542	16,105,856	27,264,535
1904....	5,991,714	18,883,455	15,530,122	1911....	6,985,416	16,443,758	28,426,375
1905....	6,112,585	20,240,809	16,419,614	1912....	6,759,119	16,306,659	28,592,536
1906....	6,773,478	20,681,625	17,467,486	1913....	7,212,648	14,937,214	31,677,871
Percentage of increase (+) or decrease (−) in 1912 and 1913....					+6.71	−0.840	+10.79

It is noticeable that whereas the values for building and monumental stone show considerable fluctuation, those for crushed stone show continued increase except for the year 1908, when a sharp decrease was shown, with entire recovery in 1909.

EXPORTS AND IMPORTS.

The following figures compiled from statistics furnished by the Bureau of Foreign and Domestic Commerce of the Department of Commerce, give the value of the exports and imports of stone for the calendar years 1912 and 1913:

Exports of stone from the United States in 1912 and 1913.

Kind.	1912	1913
Marble and stone, unmanufactured	$645,889	$606,745
All others	1,193,989	1,250,147
Total	1,839,878	1,856,892

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Imports of stone into the United States in 1912 and 1913.

Kind.	1912		1913	
	Quantity.	Value.	Quantity.	Value.
Marble:				
In block, rough, etc.....cubic feet..	636,843	$1,001,703	643,225	$1,024,595
Sawed or dressed.....do....	117	148	221	605
Slabs or paving tiles.....sup. feet.	311,895	79,577	275,888	50,788
All other manufactures.....	.....	249,008	.....	242,674
Mosaic cubes (loose).....pounds..	2,156,611	20,551	* 3,660,280	48,944
Total.....	.....	1,359,987	.....	1,367,607
Onyx:				
In blocks, rough, etc.....cubic feet..	13,029	49,237	10,067	34,518
All other manufactures.....	.....	713	.....	1,803
Total.....	.....	49,950	.....	36,321
Granite:				
Dressed.....	.....	108,917	.....	110,451
Rough.....cubic feet..	9,467	3,421	13,701	5,074
Total.....	.....	112,338	.....	115,525
Stone (other):				
Dressed.....	.....	16,951	.....	23,422
Rough.....cubic feet..	54,012	23,005	125,085	63,260
Total.....	.....	39,956	.....	86,682
Grand total.....	.....	1,562,231	.....	1,606,135

* Quantity estimated for last three months of 1913.

The export table shows the slight increase of $17,014, or 0.92 per cent, in the export trade in stone for 1913. The total exports for 1913 were valued at $1,856,892. The value of the stone imported also increased somewhat, or from $1,562,231 in 1912 to $1,606,135 in 1913, a gain of $43,904, or 2.81 per cent.

TARIFF.

The tariff act of October, 1913, made some changes in the duty imposed on imported stone, and the following table shows the duty prior to October, 1913, and the present duty.

Duty imposed on stone imported into the United States prior to and after the tariff act of October, 1913.

Stone.	Duty.	
	Prior to act of October, 1913.	After act of October, 1913.
Marble:		
In block, rough, etc.....cu. ft..	$0.65	$0.50
Sawed or dressed.....do....	1.00	.75
Slabs or tiles—		
Not over 1 inch thick—unrubbed.....sup. ft..	.08	.06
Not over 1 inch thick—rubbed.....do....	.10	.08
Over 1 inch and not over 1½ inches thick—		
Unrubbed.....do....	.10	.08
Rubbed.....do....	.12	.10
Over 1½ inches and not over 2 inches thick—		
Unrubbed.....do....	.12½	.10
Rubbed.....do....	.14½	.12
All other marble manufactured.....ad valorem..	50 per cent.	45 per cent.
Mosaic cubes, loose.....do....	¼ cent per pound +20 per cent.	20 per cent.

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Duty imposed on stone imported into the United States prior to and after the tariff act of October, 1913—Continued.

Stone.	Duty.	
	Prior to act of October, 1913.	After act of October, 1913.
Onyx:		
In block, rough, etc.....cu. ft..	$0.65	$0.50
All other manufactured.....ad valorem..	50 per cent.	45 per cent.
Granite:		
Dressed.....do....	50 per cent.	25 per cent.
Rough.....cu. ft..	$0.10	$0.03
Freestone, sandstone, limestone, lava, and all other monumental or building stone, except granite, marble, breccia not specially provided for:		
Dressed.....ad valorem..	50 per cent.	25 per cent.
Rough.....cu. ft..	$0.10	$0.03
Freestone, granite, sandstone, and limestone unmanufactured and unsuitable for monumental or building stone.	.....	Free.

GRANITE.

PRODUCTION.

The figures given in this report as representing the value of the granite production in the United States include also the value of small quantities of syenite, gneiss, schist, basalt, tuff, trachyte, andesite, and other crystalline and igneous rocks. The quantities of these allied rocks quarried are too small to tabulate separately, and the production of the igneous rocks other than granite would have to be concealed for certain States because there are less than three producers reporting. The quarrying of trap rock, consisting largely of basalt and diabase in California, Connecticut, Hawaii, Massachusetts, northern Michigan, New Jersey, New York, Oregon, Pennsylvania, and Washington, represents, however, an industry sufficient by itself to make it practicable to tabulate this stone separately, and therefore its value is not included in the grand total of granite.

For the first time the statistics of basalt quarried in Oregon and Washington have been separated from the granite figures and included under trap rock. This was done for the 1912 figures as well as for those for 1913 in order to make the two years comparable and accounts for the changes made in the 1912 figures as published in the present report.

The value of granite produced in the United States in 1913 was $20,793,800, an increase of $1,570,498, or 8.17 per cent, as compared with $19,223,302, the value in 1912. Granite for all purposes except curbing, flagging, and railroad ballast increased in value in 1913.

Fourteen States reported a granite production valued at more than $500,000 in 1913 in the following order: Vermont, Massachusetts, Maine, New Hampshire, California, North Carolina, Pennsylvania, Minnesota, Wisconsin, Georgia, Maryland, Connecticut, New York, and Rhode Island. In 1912 the order was as follows: Vermont, Massachusetts, Maine, California, New Hampshire, Wisconsin, North Carolina, Minnesota, Georgia, Rhode Island, Connecticut, Maryland, and Pennsylvania.

In 1913 the first eight States produced granite valued at more than $1,000,000; in 1912, the first six. In 1913, Vermont, New Hamp-

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shire, North Carolina, Pennsylvania, and Minnesota showed an increase in value of output; in 1912, these States were Vermont, New Hampshire, North Carolina, Minnesota, Connecticut, and Pennsylvania. The large increase in Pennsylvania was due to increased activity in the use of crushed stone for road material quarried in the vicinity of Philadelphia. In New York a considerable quantity of stone from excavations in New York City was used for riprap and crushed for use in concrete work.

The following table shows the value of the production of granite, including a small output of other igneous rocks, in the United States from 1909 to 1913, inclusive:

Value of granite, etc., produced in the United States, by States and Territories, 1909–1913.

State or Territory.	1909	1910	1911	1912	1913
Alabama			(a)		
Arizona	(a)	(a)	$13,105	$26,501	$13,270
Arkansas	$150,179	$226,690	354,041	366,354	378,110
California	1,310,520	1,520,299	1,738,094	1,583,583	1,451,149
Colorado	74,326	93,679	137,356	55,010	84,497
Connecticut	610,514	410,535	574,673	761,757	755,334
Delaware	456,328	357,708	218,284	193,074	280,987
District of Columbia			(a)		
Georgia	843,542	1,049,186	847,023	823,207	906,470
Hawaii	68,955	139,724	(b)	(b)	(b)
Idaho	(a)	(a)	(a)	30,300	113,710
Maine	1,939,524	2,315,720	2,257,034	1,803,679	1,790,279
Maryland	771,224	982,746	845,936	749,555	806,259
Massachusetts	2,164,619	1,567,754	2,361,624	2,220,279	2,133,407
Michigan	c 660,823	c 858,734	797,244	950,033	1,000,917
Minnesota					
Missouri	155,717	120,663	139,070	97,776	42,484
Montana	(a)	(a)	29,670	28,666	31,520
Nevada		(a)	(a)	(a)	
New Hampshire	1,215,461	1,239,656	1,017,272	1,311,488	1,482,771
New Jersey	60,175	80,105	167,112	142,515	62,637
New Mexico	(a)	(a)	(a)	(a)	(a)
New York	443,910	330,716	344,038	431,910	746,826
North Carolina	743,876	839,742	772,685	983,615	1,116,475
Oklahoma	67,584	102,566	20,244	14,460	30,678
Oregon	d 284,135	d 1,080,009	d 580,978	e 16,721	e 37,807
Pennsylvania	507,814	478,919	491,428	575,680	1,102,206
Rhode Island	933,053	521,490	957,743	767,507	642,375
South Carolina	218,045	369,448	335,617	263,905	360,476
South Dakota			(a)	(a)	(a)
Texas	173,271	66,909	70,488	67,613	76,067
Utah	7,525	6,783	5,209	8,975	(a)
Vermont	2,811,744	2,694,474	2,730,719	3,047,954	3,782,235
Virginia	488,250	503,106	420,611	470,657	462,162
Washington	d 742,878	d 642,992	d 1,345,551	e 140,581	e 140,279
Wisconsin	1,442,305	1,475,342	1,382,309	1,179,018	927,616
Other States	235,300	466,262	239,120	110,929	15,797
Total	19,581,597	20,541,967	21,194,228	19,223,302	20,793,800

a Included in "Other States."
b Basalt, included under trap rock.
c Includes a small value for trap rock in Michigan and Minnesota.
d Includes basalt or trap rock.
e Exclusive of basalt or trap rock.

The following table shows the value of the granite, including small values for trap and other igneous rocks, produced in the United States in 1912 and 1913, by States and Territories and uses:

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Value of granite and other igneous rocks in the United States in 1912 and 1913, by States and Territories and uses.

1912.

State or Territory.	Sold in the rough.					Dressed for—		Made into paving blocks.
	Building.	Monumental.	Rubble.	Riprap.	Other.	Building.	Monumental.	
Arizona	$325	$1,720				$1,000	$4,650	
Arkansas			$126,460					
California	32,935	53,929	6,919	$111,717	$2,904	307,997	90,825	$115,650
Colorado	10,300	35,260	900					
Connecticut	53,168	34,099	934	298,224	827	203,739	50,454	48,209
Delaware	5,243			109,699	15	419		8,617
Georgia	15,930	41,385	31,541	31,080	50	140,396	700	58,289
Idaho	700							
Maine	307,422	40,875	17,815	836	1,302	563,482	65,722	670,520
Maryland	95,570	14,826	76,336	83	888	39,210	17,797	60,853
Massachusetts	190,585	424,813	21,706	107,425	48,005	778,403	20,700	358,876
Minnesota	19,018	61,995	7,609	30,610	290	229,048	430,982	75,820
Missouri	5,629	35,273	1,816	2,518		700	9,900	5,927
Montana	809	500	500			15,164	7,242	1,695
Nevada								
New Hampshire	70,533	66,879	5,845	6,052	4,006	571,661	168,784	207,256
New Jersey	25,880	15,200	380	2,115	400	450		
New Mexico								
New York	25,329	5,541	23,731	32,071	1,890	160,959	10,265	
North Carolina	52,265	27,800	8,884	3,050	1,014	216,523	18,500	212,990
Oklahoma	2,000	8,450					2,610	
Oregon		1,700				2,230	12,791	
Pennsylvania	243,506	10,560	7,840	93,729	20,399	64,211	44,300	13,442
Rhode Island	14,331	178,565	1,514	512	55	164,752	269,074	37,449
South Carolina	5,450	70,273	1,658	8,300		300	42,245	166
South Dakota								
Texas	8,058	30,880		9,445		800	5,000	
Utah	5,500	3,400					75	
Vermont	34,433	1,367,149	2,830		6,680	1,323,787	286,503	12,016
Virginia	28,617	8,820	32,554	59,575		3,852	7,526	79,046
Washington	583	1,628	13,180			30,822	10,501	7,877
Wisconsin	1,018	13,076	1,575	168	188	49,499	500,177	497,307
Other States[a]						1,300	12,000	
Total	1,255,137	2,554,596	392,527	907,209	97,913	4,870,704	2,089,323	2,562,005

State or Territory.	Curbing.	Flagging.	Crushed stone.			Other.	Total.
			Road making.	Railroad ballast.	Concrete.		
Arizona					$18,806		$26,501
Arkansas			$101,917	$96,858	41,119		366,354
California	$109,810	$175	301,304	183,789	250,256	$15,373	1,583,583
Colorado			6,750		1,800		55,010
Connecticut	33,359	814	14,512		12,149	11,269	761,757
Delaware	2,435	179	27,861	14,070	24,536		193,074
Georgia	231,897	8,070	26,542	47,223	188,254	1,850	823,207
Idaho			9,000	16,000	4,600		30,300
Maine	105,649	4,860	5,062	14,000	5,075	1,059	1,803,679
Maryland	5,900	584	207,089	129,347	97,251	3,821	749,555
Massachusetts	108,304	2,750	94,555	3,985	51,629	8,543	2,220,279
Minnesota	23,470		33,607	15,000	22,400	184	950,033
Missouri	2,950				33,063		97,776
Montana	635				2,121		28,666
Nevada							(b)
New Hampshire	63,728	16,610	2,875	2,527	20,228	14,504	1,311,488
New Jersey			35,585	55,085	6,520	900	142,515
New Mexico							(b)
New York	3,111		41,553		127,220	240	431,910
North Carolina	130,506	4,510	60,691	33,254	206,579	7,049	983,615
Oklahoma					1,400		14,460
Oregon							16,721
Pennsylvania	3,941	100	16,522	17,573	28,867	1,690	575,680
Rhode Island	7,891		64,777		24,140	4,502	767,507
South Carolina	2,535		41,252	21,234	67,878	2,559	263,905
South Dakota							(b)
Texas	700				12,730		67,613
Utah							8,975
Vermont	912		100	2,000	11,544		3,047,954
Virginia	16,774	438	54,540	49,480	115,427	14,008	470,657
Washington	40,596	450	797,854		11,188	780	140,581
Wisconsin	2,106	1,900	49,038		62,936	30	1,179,018
Other States[a]	1,000	200		96,429			110,929
Total	898,209	41,640	1,218,108	797,854	449,716	88,361	19,223,302

[a] Includes Nevada, New Mexico, and South Dakota. [b] Included in "Other States."

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Value of granite and other igneous rocks in the United States in 1912 and 1913, by States and Territories and uses—Continued.

1913.

State or Territory.	Sold in the rough.					Dressed for—		Made into paving blocks.
	Building.	Monumental.	Rubble.	Riprap.	Other.	Building.	Monumental.	
Arizona	$2,700	$3,570					$1,000	
Arkansas	63		$58,005	$37,000				
California	90,548	44,054	6,846	61,096	$1,204	$416,125	61,215	$109,902
Colorado	8,353	45,730	414			2,000		
Connecticut	35,202	40,352	3,375	340,080	952	141,214	94,456	46,640
Delaware	13,880	270	191,480	5,691		3,931		1,696
Georgia	14,446	29,043	30,266	21,141	50	200,496	42,886	172,831
Idaho	750		100			300		
Maine	208,028	39,224	26,526	18,707	21,104	633,140	27,189	702,318
Maryland	89,849	14,474	61,062	7,627	500	7,700	27,555	41,152
Massachusetts	197,961	400,652	27,619	46,251	52,631	720,404	30,240	395,380
Minnesota	14,279	76,644	9,581	60,695		146,352	490,564	85,150
Missouri	869	16,552		1,691		1,425	360	4,882
Montana	770	500	100			22,850	2,000	
New Hampshire	51,961	98,662	33,228	1,561	2,589	553,333	194,995	451,545
New Jersey	672	547	2,400	1,342	620		4,061	
New Mexico								
New York	11,990	3,832	25,981	259,148	600	30,871	8,754	28,000
North Carolina	62,103	18,571	36,916		50	304,642	23,615	215,133
Oklahoma	6,200	18,150	128			600	2,000	
Oregon	80	1,500				200	10,015	
Pennsylvania	333,598	4,035	10,871	180,901	33,418	53,179	39,865	49,440
Rhode Island	38,631	154,453	279	1,014	100	67,041	230,440	66,018
South Carolina	440	86,247	2,752	37,883	150	690	59,589	8,844
South Dakota								
Texas	6,453	33,946		28,918			6,000	
Utah								
Vermont	43,621	1,453,818	4,566	124	13,522	2,008,240	239,18	3,162
Virginia	47,980	11,797	38,854	42,000	58	4,200	3,294	73,795
Washington	2,211	1,674		9,568		29,167	9,335	20,632
Wisconsin	1,451	18,843	2,082	400	342	10,829	486,913	279,465
Other States[a]	7,057	1,167		1,100		200	6,223	
Total	1,292,236	2,613,307	573,431	1,163,938	127,890	5,369,179	2,101,777	2,755,995

State or Territory.	Curbing.	Flagging.	Crushed stone.			Other.	Total.
			Road making.	Railroad ballast.	Concrete.		
Arizona				$265	$5,735		$13,270
Arkansas			$159,423	60,493	63,126		378,110
California	$92,745		222,259	186,125	156,143	$2,887	1,451,149
Colorado			28,000				84,497
Connecticut	25,365	$284	16,511		12,550	8,363	765,334
Delaware	3,659		37,522	21,327	10,496	35	289,957
Georgia	189,736	720	32,100	49,884	98,726	24,145	906,470
Idaho			15,000	70,560	27,000		113,710
Maine	84,686	6,754	2,055	324	16,262	3,962	1,790,279
Maryland	6,820	665	256,958	136,485	149,320	5,572	806,259
Massachusetts	132,646	1,870	46,612	4,408	48,030	18,687	2,133,407
Minnesota	18,976		19,806	600	78,230	50	1,000,917
Missouri					12,712	3,993	42,484
Montana	1,800		500		3,000		31,520
New Hampshire	70,498	1,175	6,415	129	10,297	11,383	1,482,771
New Jersey			7,680	44,373	922		62,637
New Mexico							[b]
New York			32,900		342,170	2,580	746,826
North Carolina	92,240		57,888	67,828	235,548	1,941	1,116,475
Oklahoma					3,600		30,678
Oregon			26,000		12		37,807
Pennsylvania	9,353	159	327,129	12,311	33,822	14,125	1,102,206
Rhode Island	11,000		58,500	3,000	7,996	3,903	642,375
South Carolina	9,560		47,776	43,950	61,757	838	380,476
South Dakota							[b]
Texas			50				76,067
Utah							[b]
Vermont	1,737		1,877	664	11,717		3,782,235
Virginia	11,681		86,618	34,916	94,969	12,000	462,162
Washington	51,478		6,980	6,000		3,234	140,279
Wisconsin	410	1,525	54,803		70,553		927,616
Other States[a]							15,797
Total	814,290	13,172	1,552,062	743,642	1,555,183	117,698	20,793,800

[a] Includes New Mexico, South Dakota, and Utah. [b] Included in "Other States."

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Building stone.—About 32 per cent of the value of granite output is represented by building stone, which, including rough and dressed stone, was valued at $6,661,415 in 1913, of which nearly one-fifth was the value of rough stone and four-fifths the value of the dressed stone sold. In 1912 this value was $6,125,841, or an increase of $535,574 in 1913. Over 30 per cent of the building stone value is represented by Vermont's output, which is chiefly dressed stone. Massachusetts, Maine, and New Hampshire follow next in order, producing respectively 14, 13, and 9 per cent of the granite used for building, the stone in these States also being sold chiefly as dressed stone. Pennsylvania contributes most of the rough stone.

Monumental stone.—Nearly 23 per cent of the value of granite in 1913 was for monumental stone (rough and dressed), the total value of which was $4,715,084, an increase of $71,165, or 1.53 per cent, over the value for 1912, which was $4,643,919. The total value is almost equally divided between rough and dressed stone, both of which increased in value in 1913. Vermont's output was nearly 36 per cent of the total monumental stone, representing both rough and dressed stone. The next State in rank was Minnesota, producing, however, only 12 per cent.

Rubble.—Rubble increased in value $180,904 in 1913, or from $392,527 in 1912 to $573,431 in 1913.

Riprap.—Stone for riprap increased in value $256,729 in 1913, or to $1,163,938 from $907,209 in 1912.

Paving blocks.—Paving blocks represent over 13 per cent of the value of the granite output. Maine, New Hampshire, Massachusetts, Wisconsin, North Carolina, Georgia, and California, in the order named, are the largest producers of this material.

The following table shows the quantity and value of granite paving blocks produced in the United States in 1912 and 1913 by States:

Number and value of granite paving blocks produced in 1912 and 1913, by States and Territories.

State.	Paving blocks.			
	1912		1913	
	Number.	Value.	Number.	Value.
California	2,228,835	$115,650	2,096,567	$109,902
Connecticut	968,640	48,209	992,509	46,640
Delaware	211,180	8,617	46,430	1,696
Georgia	2,324,900	58,289	4,910,958	172,831
Maine	12,795,125	670,520	13,266,644	702,318
Maryland	1,030,331	60,853	681,000	41,152
Massachusetts	7,070,082	358,876	7,885,001	395,390
Minnesota	1,097,700	75,820	1,126,000	85,150
Missouri	95,400	5,927	104,175	4,882
Montana	17,472	1,095		
New Hampshire	8,153,800	297,256	10,979,474	451,545
New York			400,000	28,000
North Carolina	5,079,343	212,990	4,415,311	215,133
Pennsylvania	280,205	13,442	1,041,718	49,440
Rhode Island	780,382	37,449	1,128,581	66,018
South Carolina	5,600	166	231,710	8,844
Vermont	344,015	12,016	70,654	3,162
Virginia	1,980,943	79,046	1,595,628	73,795
Washington	98,000	7,877	182,092	20,632
Wisconsin	9,974,076	497,307	5,308,092	279,465
Total	44,536,029	2,562,005	56,462,544	2,755,995
Average price per thousand		$57.53		$48.81
Percentage of increase in 1913 as compared with 1912			26.78	7.57

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These figures give the quantity and value of paving blocks quarried and sold by the quarrymen. In some of the States, notably Vermont, a considerable quantity of stone is sold to paving block manufacturers, who manufacture the blocks and market them. As these firms have no connection with the quarries, and the stone purchased by them is already reported by the quarrymen as sold rough, the blocks manufactured are not included in the figures of the paving-block industry. This output in Vermont, however, amounted to about 1,400,000 blocks, valued at about $56,000, in 1912, and about 2,800,000 blocks, valued at about $109,000, in 1913. A change was made in the Vermont 1912 figures to conform to those for 1913. In Massachusetts the quarrymen themselves sell the paving blocks manufactured by the "motion" men, who manufacture the blocks from their stone, and these blocks are included in the total.

The paving-block business showed a decided increase in quantity in 1913 as compared with 1912, but, while the value of the output also increased, the average price per thousand decreased. The increase in quantity was from 44,536,029 blocks in 1912 to 56,462,544 blocks in 1913, a gain of 11,926,515 blocks, or 26.78 per cent. The increase in value was from $2,562,005 in 1912 to $2,755,995 in 1913, a gain of $193,990, or 7.57 per cent. The average price per thousand was $47.99 in 1911, $57.53 in 1912, and $48.81 in 1913, a decrease of $8.72 for 1913, although practically the price was the same for 1913 as for 1911. The value of the blocks varies with the size and with the dressing, and ranges from about $25 to $100 per thousand.

A large proportion of the output from Minnesota and Wisconsin supplies the Chicago market. The blocks for Baltimore, New York, Philadelphia, and other large eastern cities as well as for the central and southern cities are supplied by Massachusetts, Maine, North Carolina, New Hampshire, New Jersey, Georgia, Pennsylvania, and other granite-producing States of the Atlantic seaboard. The Pacific coast demand is met by the quarries in the States situated on that coast.

Curbing.—Granite for curbing decreased in value $83,919, or from $898,209 in 1912 to $814,290 in 1913. Georgia, Massachusetts, California, North Carolina, and Maine are the largest producers of this material.

Flagging.—But a small part of the total granite output is used for flagstone, and this was one of the three products in which the granite output showed a decrease. The decrease amounted to $28,468, or from $41,640 in 1912 to $13,172 in 1913.

Crushed stone.—Granite in the form of crushed stone represents a little more than 18 per cent of the value of the total granite output and 12 per cent of the value of the crushed stone produced in the United States.

There was an increase in 1913 of 273,419 short tons in quantity and $385,209 in value of the crushed granite, or from 4,609,005 short tons, valued at $3,465,678, in 1912 to 4,882,424 short tons, valued at $3,850,887, in 1913. About 75 per cent of this crushed stone is used for road making and concrete—nearly equally divided between the two—and the remaining 25 per cent for railroad ballast. Road making and concrete increased in output, while stone for railroad ballast decreased somewhat. The average value per short ton was 75 cents in 1912 and 79 cents in 1913, an increase of 4 cents per short ton.

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Other purposes.—Rough stone sold for a variety of purposes not given on the statistical card increased from $97,913 in 1912 to $127,890 in 1913, a gain of $29,977; and worked stone sold for a variety of purposes increased $29,337, or from $88,361 in 1912 to $117,698 in 1913.

GRANITE IN INDIVIDUAL STATES.

GENERAL STATEMENT.

It is always recognized that statistics are of much greater service when both the quantity and the value are given, and the Survey has endeavored to render the stone statistics as complete as possible by publishing such figures of quantity as can be compiled from the data reported by the quarrymen. Owing to the various units of measurement used and to the lack of uniformity of some of the units, and also because many operators give no unit, it is difficult to compile figures of quantity. However, the majority of producers in several of the larger granite States report quite conformable figures of quantity, and below is given the output of Maine, Minnesota, New Hampshire, Vermont, and Wisconsin, showing the quantity and the distribution of the output by counties. No county figures are published unless there are three or more producers in the county. As requests have been made for the output of Massachusetts according to the distribution of the output, the figures of value are given by counties as far as they can be made available. It is to be regretted that the quantities for this State can not also be published.

MAINE.

Much of the granite quarried in Maine is shipped in large blocks for cyclopean masonry. The largeness of this stone renders it somewhat difficult to handle, but on account of the nearness of much of it to water transportation and because of the fewer number of pieces to handle it does not command as high a value per cubic foot as some of the other granites. For the same reason, and because there is often so little carving on the larger blocks, the dressed stone does not show such a high average price per cubic foot. The dressed stone also varies considerably in average price, depending on the terms of the contract.

The figures below show the output by groups rather than by individual counties, the small number of producers in each county rendering this necessary.

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Production of granite in Maine in 1912 and 1913, by counties and uses.

1912.

County.	Number of operators.	Building.				Monumental.				Paving.		Crushed stone.		Curbing and flagging.		Other.	Total value.
		Rough.		Dressed.		Rough.		Dressed.									
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (number of blocks).	Value.	Quantity (short tons).	Value.	Quantity (lineal feet).	Value.	Value.	
Cumberland, Franklin, Oxford, Somerset, and York	19	48,534	$10,159	77,130	$231,727	23,171	$11,300	3,438	$2,889	1,357,552	$60,818	31,051	$22,792	19,150	$5,565	$1,338	$348,964
Hancock	32	858,083	280,237	27,727	46,553	3,130	1,085	6,050	8,700	2,002,879	97,834	1,007	995	192,136	101,118	2,607	539,129
Kennebec, Knox, Lincoln, and Waldo	17	18,243	10,245	110,246	283,652	42,291	22,635	10,877	44,766	9,369,694	508,643	325	350	1,616	1,450	17,067	888,808
Washington and Aroostook	9	7,305	6,781	475	1,550	4,885	5,855	4,851	9,367	65,000	3,225	.....	.....	5,621	2,376	.....	25,778
Total	77	932,165	307,422	215,578	563,482	73,477	40,875	25,216	65,722	12,795,125	670,520	32,383	24,137	218,523	110,509	21,012	1,803,679
Average price	.....	.....	$0.33	.....	$2.61	.....	$0.56	.....	$2.61	Per M, $52.40		.....	$0.75	.....	$0.51	.....	.....

1913.

Cumberland, Franklin, Oxford, Somerset, and York	18	55,188	$10,322	31,866	$200,414	17,206	$11,827	3,885	$3,775	1,235,775	$61,730	21,891	$18,541	13,625	$5,335	$9,213	$321,157
Hancock	30	577,067	173,282	207,765	251,977	18,469	4,125	10,020	7,740	2,592,794	130,323	.....	.....	180,211	86,105	42,105	696,657
Kennebec, Knox, Lincoln, and Waldo	15	50,173	24,424	94,603	178,799	11,948	8,795	2,451	7,270	9,431,875	509,921	138	100	.....	.....	18,981	748,290
Washington and Aroostook	7	.....	.....	705	1,950	19,263	14,477	2,852	8,404	6,200	344	.....	.....	.....	.....	.....	25,175
Total	70	682,428	208,028	334,939	633,140	66,886	39,224	19,208	27,189	13,266,644	702,318	22,029	18,641	193,836	91,440	70,299	1,790,279
Average price	.....	.....	$0.30	.....	$1.89	.....	$0.59	.....	$1.42	Per M, $52.94		.....	$0.85	.....	$0.47	.....	.....

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Maine was one of the larger States which showed a decreased granite production, although this decrease was only $13,400, or from $1,803,679 in 1912 to $1,790,279 in 1913. The only products which increased were dressed building stone and paving blocks. The building stone, however, decreased considerably in average price, while paving blocks increased 54 cents in average price per thousand.

MASSACHUSETTS.

It has not been found possible to show the quantity of granite quarried in Massachusetts, but the figures given below serve to show the distribution of the product and the principal uses. Massachusetts, like Maine, was one of the larger granite-producing States showing a decrease in output. This decrease was small, from $2,220,279 in 1912 to $2,133,407 in 1913, and amounted to only $86,872, or less than 4 per cent.

Value of granite produced in Massachusetts in 1912 and 1913 by counties and uses.

1912.

Number of operations.	County.	Building.		Monumental.		Paving blocks.	Crushed stone.	Other.[a]	Total value.
		Rough.	Dressed.	Rough.	Dressed.				
6	Berkshire, Franklin, Hampden, and Hampshire	$750	$93,200	$28,466	$50	$13,000	$22,106	$19,817	$177,391
12	Bristol and Plymouth	37,115	32,205	649	.....	38,065	14,214	34,002	156,250
17	Essex	106,195	190,901	41,064	.....	241,593	34,895	123,234	737,882
19	Middlesex	7,742	155,120	.....	.....	47,105	22,466	52,612	285,045
17	Norfolk	7,681	7,537	354,494	20,650	8,850	36,000	54,390	489,592
10	Worcester	31,102	299,440	140	.....	10,263	20,486	12,688	374,119
81	Total	190,585	778,403	424,813	20,700	358,876	150,169	296,733	2,220,279

1913.

5	Berkshire, Franklin, Hampden, and Hampshire	$75	$60,090	$39,981	$2,000	$1,800	$15,190	$14,004	$133,146
13	Bristol and Plymouth	55,662	13,583	400	250	11,896	13,879	27,153	122,823
14	Essex	84,003	128,296	34,228	.....	285,843	35,025	77,698	645,093
21	Middlesex	2,707	61,368	80	4,681	85,335	12,445	75,639	242,255
15	Norfolk	45,174	4,310	325,763	23,265	4,000	.....	47,395	449,907
11	Worcester	10,340	462,751	200	50	6,516	22,511	37,815	540,183
79	Total	197,961	730,404	400,652	30,246	395,390	99,050	279,704	2,133,407

[a] Other includes stone sold for riprap, rubble, curbing, flagging, and other minor uses.

MINNESOTA.

Minnesota showed the small increase of $50,884 in value of granite output in 1913, from $950,033 in 1912 to $1,000,917. The increase was distributed over all uses except building stone, which decreased in quantity, value, and average price per ton. There was a notable increase of $6.55 in the average price per thousand of the paving blocks, or from $69.07 per thousand in 1912 to $75.62 per thousand in 1913. To prevent publishing individual figures the productions of neighboring counties are combined, and for the same reason the rough stone and the dressed stone are given together. Minnesota has

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attained considerable importance as a granite-producing State, especially in the vicinity of St. Cloud the granite is a source of wealth to the State.

The stone quarried in Lake and St. Louis counties is trap rock rather than granite. The following table shows the quantity and value of the granite output of Minnesota in 1912 and 1913 by counties and uses:

Quantity and value of granite produced in Minnesota in 1912 and 1913, by counties and uses.

1912.

County.	Number of plants.	Building (rough and dressed).		Monumental (rough and dressed).		Paving blocks.		Crushed stone.		Other value.	Total value.
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Number of blocks.	Value.	Quantity (short tons).	Value.		
Lac qui Parle, Redwood, and Renville	3	925	$595	5,175	$8,444	.....	.....	.....	.....	$107	$9,146
Benton and Kanabec	5	22,000	40,536	15,200	39,200	50,000	$3,500	.....	.....	7,950	91,186
Sherbourne	5	41,250	37,127	3,862	3,189	913,700	62,545	13,462	$14,900	9,950	127,711
Stearns	15	78,101	169,808	157,642	442,144	134,000	9,775	.....	.....	16,987	638,714
Lake and St. Louis [a]	3	.....	.....	.....	.....	.....	.....	66,462	56,107	27,169	83,276
Total	31	142,276	248,066	181,879	492,977	1,097,700	75,820	79,924	71,007	62,163	950,033
Average price	.....	.....	$1.74	.....	$2.71	Per M, $69.07		.....	$0.89	.....	.....

1913.

Benton, Redwood and Renville	5	2,880	$1,875	9,350	$27,419	.....	.....	.....	.....	$8,379	$37,673
Sherbourne	5	51,762	40,369	4,870	4,240	712,000	$54,350	10,628	$13,110	5,575	117,644
Stearns	18	61,354	118,387	193,327	535,549	414,000	30,800	80	40	13,018	697,794
Lake and St. Louis [a]	3	.....	.....	.....	.....	.....	.....	99,844	85,476	62,330	147,806
Total	31	115,996	160,631	207,547	567,208	1,126,000	85,150	110,552	98,626	89,302	1,000,917
Average price	.....	.....	$1.38	.....	$2.73	Per M, $75.62		.....	$0.89	.....	.....

[a] Trap rock.

NEW HAMPSHIRE.

In compiling a detailed statement of the granite output of New Hampshire it was found that Cheshire and Hillsboro were the only counties that could be published separately, and for 1913 it was necessary to combine all of the others, although the counties were not in close proximity. The total value of the output increased from $1,311,488 in 1912 to $1,482,771 in 1913, a gain of $171,283, or 13 per cent.

The following table shows the quantity and value of the granite produced in New Hampshire in 1912 and 1913 by counties and uses:

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Quantity and value of granite produced in New Hampshire in 1912 and 1913 by counties and uses.

1912.

Number of operators.	County.	Building.				Monumental.				Paving.		Curbing and flagging.		Crushed stone.		Other value.	Total value.
		Rough.		Dressed.		Rough.		Dressed.		Number of blocks.	Value.	Quantity.	Value.	Quantity.	Value.		
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.								
		Cu. ft.		*Cu. ft.*		*Cu. ft.*		*Cu. ft.*				*Linear feet.*		*Short tons.*			
6	Carroll and Merrimack	19,378	$7,446	174,431	$460,436	32,453	$16,670	7,024	$27,642	2,439,315	$87,131	12,197	$5,981	14,891	$14,219	$2,974	$622,499
7	Cheshire	37,237	13,040	25,691	77,657	18,575	18,706	16,267	49,847	700,235	29,288	36,115	13,758	12,109	9,176	7,088	218,660
3	Coos, Grafton, and Strafford	9,900	750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,470	2,235	14,000	16,985
19	Hillsboro	94,809	49,297	28,480	33,568	33,132	31,503	21,923	91,295	5,014,250	180,837	157,549	60,599	.....	.....	6,345	453,444
35	Total	161,324	70,533	228,602	571,661	84,160	66,879	45,214	168,784	8,153,800	297,256	205,861	80,338	31,470	25,630	30,407	1,311,488
	Average price	.....	$0.44	.....	$2.50	.....	$0.80	.....	$3.73	Per M, $36.46		.....	$0.39	.....	$0.81	.....	.....

1913.

9	Carroll, Grafton, Strafford, and Merrimack	27,990	$10,351	146,592	$458,842	35,064	$18,199	13,838	$53,099	2,986,720	$124,700	8,989	$4,638	17,574	$15,468	$17,257	$702,754
9	Cheshire	77,079	24,102	33,534	85,786	24,345	19,794	6,917	19,851	1,425,475	56,572	175	44	731	373	26,654	233,176
18	Hillsboro	56,514	17,508	8,894	8,705	60,343	55,669	32,028	122,045	6,567,279	270,273	208,316	66,991	2,000	1,000	4,650	546,841
36	Total	161,583	51,961	189,020	553,333	119,752	93,662	52,783	194,995	10,979,474	451,545	217,480	71,673	20,305	16,841	48,761	1,482,771
	Average price	.....	$0.32	.....	$2.93	.....	$0.78	.....	$3.69	Per M, $41.13		.....	$0.33	.....	$0.83	.....	.....

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VERMONT.

The granite output of Vermont represents over 18 per cent of the total granite output of the United States, and in 1913 the State produced $1,648,828 more granite than its closest competitor, Massachusetts. Vermont's output in 1913 was valued at $3,782,235 and that of Massachusetts at $2,133,407. The total for Vermont represented an increase of $734,281, or 24 per cent, over the value for 1912, which was $3,047,954.

As the granite industry is one of the principal sources of the State's wealth, the following detailed statement of output is of interest. The following table shows the production of granite in Vermont in 1912 and 1913, by counties and uses:

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Production of granite in Vermont in 1912 and 1913, by counties and uses.

1912.

County.	Number of active firms reporting.	Building.				Monumental.				Paving.		Other uses.	Total value.
		Rough.		Dressed.		Rough.		Dressed.					
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (number of blocks).	Value.	Value.	
Washington, Orange, and Windsor	24	29,388	$25,474	389,028	$1,322,567	1,320,744	$1,325,794	72,306	$252,103	216,015	$7,020	$20,013	$2,952,971
Essex and Orleans	6	5,309	2,659	1,500	750	35,405	16,405	5,000	12,000	.....	.....	3,080	34,894
Windham	3	5,500	2,500	172	470	.....	.....	.....	.....	126,000	4,920	973	8,863
Caledonia	7	9,000	3,800	.....	.....	53,618	24,950	28,000	22,400	2,000	76	.....	51,226
Total	40	49,197	34,433	390,700	1,323,787	1,409,767	1,367,149	105,306	286,503	344,015	12,016	24,066	3,047,964
Average price per cubic foot	.....	.....	$0.70	.....	$3.39	.....	$0.97	.....	$2.72	Per M,	$34.93	.....	.....

1913.

Washington, Orange, and Windsor	24	44,803	$38,639	546,335	$2,004,724	1,377,974	$1,403,090	67,253	$235,087	.....	.....	$30,930	$3,712,465
Orleans	5	20	210	3,040	3,040	25,140	12,520	3,000	2,100	.....	.....	900	18,505
Windham	5	8,844	4,272	190	476	150	75	.....	.....	70,654	$3,162	2,647	10,632
Caledonia	6	2,000	500	.....	.....	79,228	38,133	800	2,000	.....	.....	.....	40,633
Total	40	55,667	43,621	549,565	2,008,240	1,482,492	1,453,818	71,053	239,187	70,654	3,162	34,477	3,782,235
Average price per cubic foot	.....	.....	$0.78	.....	$3.65	.....	$0.98	.....	$3.37	Per M,	$44.75	.....	.....

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As previously stated in this report and in former reports, the value represents the value of the stone as sold by the quarrymen, the value being given for rough stone if sold rough and for dressed stone if sold after cutting by the quarrying firm. In Vermont the greater part of the granite is sold to granite manufacturers in the rough, and, although some of the stone is shipped in the rough, the greater part is cut in the vicinity of Barre and other centers, and this manufacturing industry forms a distinct, though dependent, source of wealth to the State. Dressed stone, including monumental and building stone, as quarried and sold by the quarrymen, amounted to only 620,618 cubic feet compared with 1,538,159 cubic feet sold rough. The dressed stone, however, was valued at $2,247,427, or an average price of $3.62 per cubic foot, while the rough stone value was reported at $1,497,439, or 97 cents per cubic foot.

If the rough stone be considered as sold in the manufactured state at the average price of dressed stone, after allowing 10 per cent for waste, the total value for Vermont, including stone sold for paving blocks, curbing, rubble, crushed stone, etc., would represent an industry amounting in 1913 to nearly $6,000,000.

The most notable feature of the granite production in Vermont in 1913 was the increase in the stone used for building purposes, which, including rough and dressed stone, amounted to 439,897 cubic feet in 1912 and increased to 605,232 cubic feet in 1913.

The paving-block industry in Vermont has never been of especial importance when compared with the size of this industry in the nearby States of Maine, New Hampshire, and Massachusetts. The greater number of blocks made in this State are not made by the quarrymen, but made from stone sold by them to firms who manufacture and sell the finished product. For this reason the stone sold by the quarrymen for paving blocks is included under rough stone, and the table of production does not include the entire number of blocks manufactured in the State. Owing to a misconception, the figures given in previous years did not represent the correct quantity and value of the blocks as sold by the quarrymen, but in this report the 1912 figures have been changed to conform with those collected in 1913. Besides the blocks reported in the table of production, there were made by paving-block contractors in 1912 about 1,400,000 blocks, valued at about $56,000, and in 1913 about 2,800,000 blocks, with an approximate value of $109,000.

WISCONSIN.

To prevent disclosure of individual figures, it was found necessary, in compiling a detailed statement of the granite production in Wisconsin, to class together the counties of Douglas, Green Lake, Oconto, and Waupaca, although these counties are not in the same part of the State. It was also necessary to include under building and monumental stone both the rough and the dressed stone, although it will readily be seen that the figures represent mostly dressed stone.

The following table shows the output of granite in Wisconsin in 1913 by counties and uses:

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Quantity and value of granite produced in Wisconsin in 1913 by counties and uses.

Number of operators.	County.	Building (rough and dressed).		Monumental (rough and dressed).		Paving blocks.		Crushed stone.		Other.	Total value.
		Quantity.	Value.	Quantity.	Value.	Quantity (number of blocks).	Value.	Quantity.	Value.	Value	
		Cubic feet.		*Cubic feet.*				*Short tons.*			
6	Douglas, Green Lake, Oconto, and Waupaca			1,000	$1,300	631,073	$31,423	72,766	$65,756	$685	$99,164
5	Marathon	794	$1,119	42,850	178,033						179,152
3	Marinette	1,920	6,600	25,343	89,676						96,276
10	Waushara and Marquette	2,120	4,561	32,745	236,747	4,677,019	248,042	74,535	59,600	4,074	553,024
24	Total	4,834	12,280	101,938	505,756	5,308,092	279,465	147,301	125,356	4,759	927,616
Average price			$2.54		$4.96	Per M. $52.65			$0.85		

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TRAP ROCK.

Besides the "trap rock" (basalt, and other dark volcanic rocks) reported in the following tables, there is a small quantity included in the figures for granite under those States in which trap rock does not form enough of an industry to warrant the separate publication of the figures.

In the value of trap rock produced in Massachusetts is included the value of slate quarried in the vicinity of Boston, which, on account of lack of fissility, is rendered unsuitable for any of the purposes for which slate is used; therefore, it is crushed and used entirely for road making.

The trap-rock industry in the Pacific coast States is known as the basalt-quarrying industry, and as stated previously in this report, the basalt quarried in Oregon and Washington has for the first time been separated from granite and included with trap-rock figures. The greater part of the production from the Washington quarries was used both in 1912 and 1913 in riprapping at the mouth of Columbia River. Also in California a large increase in the riprap production was for work done in Humboldt Bay.

There was a large increase in the value of the total output in 1913, from $7,560,049 in 1912 to $9,289,809 in 1913, an increase of $1,729,760 or 22.88 per cent.

With the exception of Washington, each of the producing States showed a considerable increase in value of output, but the rank of States changed considerably. In 1912 only two States produced trap rock valued at more than $1,000,000, California and New Jersey; in 1913 California, Massachusetts, New Jersey, Pennsylvania, and New York, in order named, each contributed more than $1,000,000 to the total. Stone used for riprap, road making, and ballasting of railroads showed the largest increase.

The following table shows the value of the trap-rock production in the United States in 1912 and 1913, by States and uses:

Value of trap rock produced in the United States in 1912–13, by States and uses.

1912.

State.	Building.	Riprap and rubble.	Paving.	Crushed stone.			Other.	Total.
				Road-making.	Railroad ballast.	Concrete.		
California	$500	$214,438	$229,261	$591,036	$340,561	$543,254	$7,297	$1,926,347
Connecticut	15,683	17,066	3,081	274,036	89,645	180,370	1,189	581,070
Hawaii	2,607	.....	.....	128,354	.....	94,140	5,750	231,351
Massachusetts	30,614	6,000	.....	303,007	10,000	564,706	914	915,241
Michigan	.....	8,500	.....	18,366	.....	9,340	.....	36,206
New Jersey	9,213	4,357	31,646	616,674	189,641	342,079	8,787	1,202,397
New York	20,000	.....	.....	376,460	39,106	396,101	.....	831,667
Oregon	755	4,721	300	128,272	14,636	102,013	70	250,767
Pennsylvania	14,458	1,860	1,347	359,844	326,512	210,331	2,031	916,383
Washington	158	575,029	.....	71,544	2,847	18,250	792	668,620
Total	93,988	831,971	265,635	2,868,093	1,012,948	2,460,584	26,830	7,560,049

1913.

California	$208	$626,477	$141,332	$507,258	$321,500	$531,009	$4,461	$2,132,245
Connecticut	9,152	7,967	1,759	349,795	55,894	288,629	327	713,323
Hawaii	750	66,478	483	97,826	25,747	52,851	5,255	249,390
Massachusetts	24,988	1,000	.....	702,803	67,474	698,424	2,500	1,497,189
Michigan	.....	51,600	.....	23,369	8,492	8,740	.....	92,201
New Jersey	18,856	4,976	50,949	701,494	250,571	322,598	10,487	1,359,931
New York	12,000	.....	.....	520,666	102,939	242,085	200,000	1,077,690
Oregon	2,265	6,228	7,658	156,471	59,873	83,512	.....	316,007
Pennsylvania	5,731	1,175	2,165	492,183	512,666	202,452	2,546	1,218,918
Washington	9,128	504,392	.....	110,969	3,998	4,428	.....	632,915
Total	83,078	1,270,293	204,346	3,662,834	1,408,954	2,434,728	225,576	9,289,809

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The following table shows the quantity and value of trap paving blocks produced in the United States in 1912 and 1913, by States:

Number and value of trap paving blocks produced in the United States, 1912–13, by States.

State.	Paving blocks.			
	1912		1913	
	Number.	Value.	Number.	Value.
California	4,906,889	$239,261	2,237,971	$141,332
Connecticut	78,600	3,081	44,250	1,759
Hawaii			36,250	483
New Jersey	1,015,841	31,646	1,470,648	50,949
Oregon	10,000	300	218,800	7,658
Pennsylvania	33,673	1,347	51,400	2,165
Total	6,045,003	265,635	4,059,319	204,346
Average price per thousand		$43.94		$50.33

MARBLE.

The figures for marble production here presented include, for some of the States, the value of serpentine (verde antique marble) and "onyx" marble. The serpentine included is that form which, from its use as ornamental stone for interior decorative work in buildings, answers the purpose of marble. The California, Georgia, Pennsylvania, and Vermont figures in this report include this stone. Onyx marble, or cave onyx, is included in the production of Kentucky and New Mexico.

In 1913 the commercial output of marble came from the following States, arranged according to value of output:

VERMONT: Bennington, Franklin, Grand Isle, Rutland, and Washington counties.
TENNESSEE: Blount, Knox, Loudon, and Union counties.
GEORGIA: Cherokee and Pickens counties.
COLORADO: Gunnison County.
ALABAMA: Talladega County.
MASSACHUSETTS: Berkshire and Hampden counties.
NEW YORK: Dutchess, St. Lawrence, Warren, and Westchester counties.
PENNSYLVANIA: Montgomery and Northampton counties.
ALASKA: Near Tokeen, Ketchikan mining district, southeastern Alaska.
CALIFORNIA: Amador, Los Angeles, Tulare, and Tuolumne counties.
MARYLAND: Baltimore and Harford counties.
NORTH CAROLINA: Cherokee County.
UTAH: Utah County.
ARKANSAS: Searcy County.
NEW MEXICO: Otero County.
WASHINGTON: Chelan County.
VIRGINIA: Loudoun County.
OREGON: Josephine County.

The value of the marble produced by Vermont in 1913 was $3,513,405, or 44.64 per cent of the total; by Tennessee, $1,416,952, or 18 per cent of the total; and by Georgia, $1,101,997, or 14 per cent of the total for the United States. With reference, however, to quantity, the total number of cubic feet reported was 3,606,818, to which Vermont contributed 1,183,400 cubic feet, or 32.81 per cent; Tennessee, 754,234 cubic feet, or 20.91 per cent; and Georgia, 1,031,373 cubic feet, or 28.6 per cent. The average price

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per cubic foot shown for Vermont was $2.97; for Tennessee, $1.88; for Georgia, $1.03. The differences in average price per cubic foot for these three leading marble States are due to the fact that most of the Vermont producers mill and sell their stone as dressed stone. The Tennessee producers sell much of their stone to mills in the vicinity or ship as finished or partly finished material from their own mills. The Georgia marble is practically all sold as rough stone.

The marble output in the United States was valued in 1912 at $7,786,458 and in 1913 at $7,870,890, a gain of $84,432, or 1.08 per cent. Most quarrymen report their output from year to year, using the same unit, so that a comparison of the cubic feet and value of the same is possible, or of the square feet or tons sold, and their corresponding value. The greater part of the marble quarried is sold by the cubic foot. In 1912 there was reported 3,370,626 cubic feet of marble, valued at $7,559,574, or $2.24 per cubic foot; in 1913, 3,606,818 cubic feet, valued at $7,605,271, or $2.11 per cubic foot, a gain for 1913 of 236,192 cubic feet and $45,697. Besides this there was produced in 1913, 376,648 square feet of sawed marble, valued at $139,260, and 106,084 short tons of marble, valued at $126,359; in 1912 the figures were 115,018 square feet, valued at $85,428, and 158,005 short tons, valued at $141,456.

Owing to the small number of producers in many of the marble-producing States, it is not possible to compile a satisfactory table showing the marble production, by States. The figures are given, however, as far as they are available.

The following table shows the value of the marble produced in the United States from 1909 to 1913, by States:

Value of marble produced in the United States, 1909–1913, by States and Territories.

State or Territory.	1909	1910	1911	1912	1913
Alabama	[a] $212,462	[b] $255,664	[c] $335,005	[d]	[d]
Alaska	[a] 46,900	[b]	[c]	[d]	[d]
Arizona	[a]		[c]		
California	80,392	[b] 112,339	29,964	576,424	572,768
Colorado	[a] 488,311	[b] 485,173	[c] 1,010,840	[d]	[d]
Georgia	766,449	953,917	1,088,422	1,096,622	1,101,997
Kentucky	[a]	[b]	[c]	[d]	
Maryland	[a]	[b]	[c] 73,300	[d]	[d]
Massachusetts	243,711	224,088	219,445	213,939	276,819
New Mexico	[a] 5,390	[b]	[c]	[d]	[d]
New York	402,720	484,732	379,670	291,210	252,982
North Carolina	[a]	[b]	[c]	[d]	[d]
Oklahoma			[c]		
Oregon	[a]				[d]
Pennsylvania	186,037	[b] 182,514	214,913	267,242	[d]
South Carolina			[c]		
Tennessee	613,741	728,502	700,229	974,733	1,416,952
Texas	[a]	[b]			
Utah	[a]	[b]	[c]	[d]	[d]
Vermont	3,493,783	3,562,850	3,394,930	3,494,253	3,513,405
Virginia				[e]	[d]
Washington	[a]	[b]			[d]
West Virginia	[a]	[b]			
Other States				1,372,085	1,225,967
Total	6,548,905	6,992,779	7,546,718	7,786,458	7,870,890

[a] Alabama includes Kentucky, Maryland, North Carolina, and West Virginia; Alaska includes Washington; New Mexico includes Arizona and Texas; Colorado includes Oregon and Utah.
[b] Alabama includes Kentucky, North Carolina, and West Virginia; California includes Alaska and Washington; Colorado includes Arizona and New Mexico; Pennsylvania includes Maryland.
[c] Alabama includes Kentucky and Oklahoma; Colorado includes Alaska, Arizona, New Mexico, Oregon, and Utah; Maryland includes North Carolina and South Carolina.
[d] Included in "Other States."
[e] Included in limestone.

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The following table shows the value of marble quarried from 1908 to 1913, according to uses:

Distribution and value of the output of marble, 1908–1913, among various uses.

Use.	1908	1909	1910	1911	1912	1913
Sold by producers in rough state	$1,455,980	$2,330,336	$2,098,480	$3,182,620	$3,358,536	$3,645,863
Dressed for—						
Building (exterior)	2,329,438	1,293,019	1,463,749	1,220,635	1,396,254	829,244
Ornamental purposes	25,506	24,695	37,950	71,000	134,826	34,850
Monumental work	1,843,426	1,184,672	1,279,985	1,368,430	720,464	1,135,658
Interior decoration in buildings	1,943,750	1,557,783	2,001,646	1,545,963	1,944,161	1,869,262
Other uses not specified	135,820	158,400	110,969	158,070	232,217	356,013
Total	7,733,920	6,548,505	6,992,729	7,546,718	7,786,458	7,870,890

The chief uses of marble are as exterior and interior building stone and for monuments. Dressed monumental stone was the only one of these products that had an increase in value, according to the preceding tables. A consideration of the figures, including both rough and dressed stone, shows the following results:

Building stone (exterior work).—Marble as building stone is sold for two different uses—one on the exterior of buildings and the other in the interior, as wainscoting, paneling, mantals, floors, stairs, balustrades, etc. The total value of building marble in 1913 was $4,982,463, or 63.3 per cent of the entire marble output. In 1913 this value included 1,667,725 cubic feet of rough stone, valued at $2,277,752, or $1.36 per cubic foot; also 6,300 short tons, valued at $4,205; and 1,000 square feet, valued at $2,000; 598,129 cubic feet of dressed stone, valued at $2,561,246, or $4.28 per cubic foot; also 375,648 square feet, valued at $137,260.

The value of marble produced in 1913 for exterior building purposes (including rough and dressed stone) and either sold or used by the producer was $1,822,458, a decrease of $949,187, compared with 1912, when this value was $2,771,645. The total for 1913 included $993,214 for rough and $829,244 for dressed building stone; in 1912 the rough building marble sold was valued at $1,375,391 and the dressed building stone at $1,396,254, a decrease in 1913 of $382,177 for rough stock and of $567,010 for dressed marble.

The quantity of marble sold in 1913 rough for exterior building was 809,114 cubic feet, valued at $989,814, or $1.22 per cubic foot, and 4,000 tons, valued at $3,400. There was 288,754 cubic feet of dressed stone, valued at $829,244, or $2.87 per cubic foot.

In 1912 the quantity of marble sold rough for building stone was 945,728 cubic feet, valued at $1,369,213, or $1.45 per cubic foot; 5,009 square feet, valued at $4,828; and 450 tons, valued at $1,350. There was 478,361 cubic feet of dressed building stone quarried, valued at $1,396,254, with an average price of $2.91 per cubic foot.

Interior decoration work.—The total value of marble for interior work in buildings (including stone sold rough and dressed) in 1913 was $3,160,005, a gain of $1,215,844, when compared with $1,944,161 in 1912. The stone sold for this work in 1913 was 1,167,986 cubic feet, valued at $3,019,940, or $2.59 a cubic foot; 376,648 square feet, valued at $139,260; and 2,300 short tons, valued at $805.

The production of this stone was 858,611 cubic feet, valued at $1,287,938, or $1.50 per cubic foot; 1,000 square feet, valued at $2,000; and 2,300 short tons, valued at $805, sold as rough stone for

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interior work; and 309,375 cubic feet, valued at $1,732,002, or $5.60 per cubic foot, and 375,648 square feet, valued at $137,260, sold in the manufactured state for this purpose. In 1912 only dressed stone was reported for interior work. This amounted to 364,769 cubic feet, valued at $1,863,561, or $5.11 a cubic foot, and 110,009 square feet, valued at $80,600, a total value of $1,944,161. In 1912 this stone as sold rough for interior building was not separated from that sold rough for exterior building, which accounts for the large difference in average price.

Monumental stone.—Monumental marble (including rough and dressed stone) was valued at $2,497,564 in 1913 and at $2,115,200 in 1912, an increase of $382,364 in 1913. In 1912 the value of rough stock was $1,394,736 and of dressed monumental stone $720,464; the corresponding figures for 1913 are $1,361,906 for rough monumental stock and $1,135,658 for dressed monumental stone, a decrease in 1913 of $32,830 in value of rough stock and an increase of $415,194 for dressed stone. In 1913 the stone sold rough for monumental use was 912,792 cubic feet, valued at $1,361,592, or $1.49 per cubic foot, and 32 tons, valued at $314. The dressed monumental stone sold amounted to 256,300 cubic feet, at $4.43 per cubic foot.

In 1912 the quantity of stone sold rough for monumental work was 867,716 cubic feet, at $1.61 per cubic foot; and that for dressed monumental work was 214,326 cubic feet, at $3.36 per cubic foot.

Other marble.—Rough stone for other uses includes waste marble sold to lime burners, to carbonic-acid factories, to pulp mills, to iron furnaces for flux, and that used for road making, etc.; the dressed stone includes stone for mosaics, electrical work, etc.

As the form of the requests to the producers for the reports of their marble output in 1912 and 1913 was slightly different, it is impossible to make a direct comparison of the marble sold in the different States in these years according to uses. The following statements of the marble output in the United States show the quantity and value of this material and the form in which it was sold by the producer in 1912 and 1913:

Total quantity and value of marble produced in the United States in 1912 and 1913, according to the use for which the stone was intended.

1912.

Form in which sold by producer.		Quantity.	Value.
In rough blocks or rough sawed:			
To dealers or manufacturers	cubic feet	403,025	$588,409
Rough:			
Direct for—			
Monumental work	do	867,716	1,394,736
Buildings	do	945,723	1,360,213
	square feet	5,009	4,828
	short tons	450	1,350
As finished work:			
Direct for—			
Monumental work	cubic feet	214,326	720,464
Buildings (exterior)	do	478,361	1,396,254
Interior decoration	do	364,769	1,863,561
	square feet	110,009	80,600
Ornamental purposes	cubic feet	76,013	134,826
As crushed stone	short tons	32,789	23,156
As ground limestone	do	8,085	26,542
For other purposes	do	116,681	90,408
	cubic feet	20,688	92,111
Total	do	3,370,626	7,559,574
	square feet	115,018	85,428
	short tons	158,005	141,456
			7,786,458

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Total quantity and value of marble produced in the United States in 1912 and 1913 according to the use for which the stone was intended—Continued.

1913.

Form in which sold by producer.		Quantity.	Value.
In rough blocks, rough sawed, or rough dressed:			
To dealers or manufacturers—			
For monumental work	cubic feet	889,048	$1,311,846
	short tons	30	300
Building—Exterior work	cubic feet	759,910	928,226
	short tons	4,000	3,400
Building—Interior decorative work	cubic feet	682,611	1,087,938
	square feet	1,000	2,000
	short tons	2,300	805
Direct for—			
Monumental work	cubic feet	23,744	49,746
	short tons	2	14
Building—Exterior work	cubic feet	49,204	61,588
Building—Interior work	do	176,000	200,000
Dressed:			
Direct for—			
Monumental work	do	256,300	1,135,658
Building—Exterior work	do	288,754	829,244
Building—Interior work	do	309,375	1,732,002
	square feet	375,648	137,260
Ornamental purposes	cubic feet	2,650	34,850
As ground limestone or crushed stone	do	37,100	17,500
	short tons	22,529	57,215
For other purposes	cubic feet	132,122	216,673
	short tons	77,223	64,625
Total	cubic feet	3,606,818	7,605,271
	square feet	376,648	139,260
	short tons	106,084	126,359
			7,870,890

The following table shows the quantity and value of the marble sold by the producers in the most prominent marble States:

Quantity and value of marble produced in California, Georgia, Massachusetts, New York, Tennessee, and Vermont in 1912 and 1913.

State.	1912		1913	
	Quantity.	Value.	Quantity.	Value.
California:				
Short tons	479	$2,874	478	$2,990
Cubic feet	28,429	73,550	37,155	69,778
Total		76,424		72,768
Georgia:				
Short tons	17,676	29,286	20,293	35,484
Cubic feet	928,191	1,067,336	1,031,373	1,066,513
Total		1,096,622		1,101,997
Massachusetts:				
Short tons	9,217	12,360	9,557	13,014
Cubic feet	104,228	197,175	92,137	176,545
Square feet	28,615	4,404	342,648	87,260
Total		213,939		276,819
New York:				
Short tons	62,219	57,243	49,014	50,301
Cubic feet	144,105	233,967	122,063	202,681
Total		291,210		252,982
Tennessee:				
Short tons	16,478	6,315		
Cubic feet	605,198	968,418	754,234	1,416,952
Total		974,733		1,416,952
Vermont:				
Short tons	600	295	6,300	4,205
Cubic feet	1,105,022	3,464,534	1,183,400	3,509,200
Square feet	54,203	29,424		
Total		3,494,253		3,513,405

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LIMESTONE.

An increase of $2,015,629, or 5.49 per cent, marks the limestone production of the United States in 1913 in comparison with 1912. The increase in value from $36,729,800 in 1912 to $38,745,429 in 1913 was almost entirely in the various branches of the crushed stone industry. The higher grades of stone for building, paving, and curbing decreased in value, as did also rubble stone. Stone for riprap, sugar factories, fluxing, and for use in the manufacturing industries, as alkali works, glass factories, paper mills, carbonic acid plants, etc., showed considerable increase.

The value given for the limestone production does not include the value of a large quantity of limestone burned into lime and sold as a manufactured product, except in cases of alkali works, sugar factories, and, to a small extent, at steel works and smelting plants where lime instead of stone is used as a flux, and the only record kept is of stone used rather than lime burned. Also a quantity of stone sold to manufacturers of lime who may require a certain kind of stone that they do not produce is here included as well as a small quantity of stone sold to farmers for burning into lime for farm use, whose record can not otherwise be obtained. The commercial output of lime is given in another chapter of Mineral Resources.

A large quantity of limestone used in the manufacture of Portland cement is also excluded from these figures; the value of this stone enters into and is included in the value of the cement, the statistics of which are also given in another chapter.

The chief States producing limestone in 1913, according to rank in value, were Pennsylvania, Ohio, Indiana, Illinois, New York, Missouri, Michigan, Kentucky, West Virginia, and Wisconsin, the first six producing over $2,000,000 each, and the last four over $1,000,000 each. In 1912 the rank was Pennsylvania, Indiana, Ohio, Illinois, New York, Missouri, Kentucky, and Michigan. Ohio took second place from Indiana in 1913, and West Virginia and Wisconsin joined the States having a production of limestone valued at more than $1,000,000. Each of these leading States, except Indiana and Kentucky, showed an increase in 1913. Pennsylvania, the largest producer of limestone, produced nearly 16 per cent of the total output, and about 68 per cent of the stone from Pennsylvania was fluxing stone and the rest chiefly crushed stone. Ohio produced nearly 13 per cent of the limestone output, of which nearly 55 per cent was for crushed stone and most of the remainder for flux. The production in Indiana represented 12 per cent of the total limestone output, and nearly 70 per cent of the output of the State was for building stone.

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The following table shows the value of limestone, by States, from 1909 to 1913, inclusive.

Value of limestone from 1909 to 1913, by States and Territories.

State or Territory.	1909	1910	1911	1912	1913
Alabama	$700,642	$714,516	$571,798	$531,085	$812,664
Arizona	(a)	(b)	8,676	19,099	6,328
Arkansas	112,468	84,280	c 136,007	66,952	52,220
California	283,989	590,990	576,701	245,235	323,287
Colorado	355,136	415,523	341,798	365,004	428,736
Connecticut	a 5,023	b 9,062	c 21,040	17,924	(d)
Florida	a 49,856	b 84,457	97,520	60,524	156,589
Georgia	34,593	24,236	31,632	53,187	83,899
Hawaii	(a)				
Idaho	(a)	19,423	c 19,497	19,791	18,569
Illinois	4,234,927	3,847,715	3,436,977	3,808,784	4,112,172
Indiana	3,749,239	4,472,241	4,406,577	5,066,337	4,649,597
Iowa	525,277	543,600	679,895	944,885	803,682
Kansas	892,335	768,739	789,448	757,197	824,005
Kentucky	903,874	978,809	1,124,170	1,160,148	1,069,034
Louisiana	(a)	(b)	(c)	(d)	(d)
Maine	(a)	(b)	(c)	(d)	(d)
Maryland	197,939	154,370	218,636	228,713	282,241
Massachusetts		(b)	(c)	(d)	(d)
Michigan	750,589	842,126	1,001,535	1,139,560	1,408,708
Minnesota	698,309	654,833	612,915	546,650	636,620
Missouri	2,111,283	2,360,604	2,179,767	2,373,725	2,486,020
Montana	154,064	169,836	148,126	154,133	260,915
Nebraska	293,830	338,731	263,459	335,369	326,287
Nevada			(c)	(d)	
New Jersey	224,017	224,709	138,148	205,334	280,680
New Mexico	a 140,801	b 227,657	243,119	237,543	148,266
New York	2,622,353	2,813,476	2,857,797	3,208,911	3,539,043
North Carolina	(a)	(b)	30,278	39,864	67,132
Ohio	4,020,046	4,357,432	4,461,882	4,885,088	4,945,310
Oklahoma	450,055	509,344	594,664	409,994	246,912
Oregon		3,594	(c)	(d)	(d)
Pennsylvania	5,073,825	5,394,611	5,243,045	6,017,308	6,189,145
Rhode Island	(a)	(b)	(c)	(d)	(d)
South Carolina		(b)	(c)		
South Dakota	a 49,328	17,150	6,250	10,628	4,098
Tennessee	a 589,949	b 747,162	c 798,369	673,329	643,586
Texas	341,528	447,239	490,289	530,251	590,289
Utah	169,700	389,603	168,145	208,245	368,007
Vermont	18,839	25,250	19,702	12,644	17,715
Virginia	342,656	471,903	369,872	403,069	598,032
Washington	38,269	36,186	32,478	20,370	62,913
West Virginia	864,392	841,064	902,077	981,467	1,046,625
Wisconsin	1,047,044	979,522	848,363	853,477	1,017,135
Wyoming	24,346	43,687	36,960	64,749	108,234
Other States				73,227	130,734
Total	32,070,401	34,603,678	33,897,612	36,729,800	38,745,429

a New Mexico includes Arizona; South Dakota includes Hawaii and Idaho; Connecticut includes Maine and Rhode Island; Florida includes Louisiana; Tennessee includes North Carolina.
b New Mexico includes Arizona; Connecticut includes Maine, Massachusetts, and Rhode Island; Florida includes Louisiana; Tennessee includes North Carolina and South Carolina.
c Arkansas includes Louisiana; Connecticut includes Maine, Massachusetts, and Rhode Island; Idaho includes Nevada and Oregon; Tennessee includes South Carolina.
d Included in "Other States."

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Value of the production of limestone in the United States in 1912 and 1913, by States and uses.

1912.

State.	Rough building.	Dressed building.	Paving.	Curbing.	Flagging.	Rubble.	Riprap.
Alabama			$15,900				$81,361
Arizona							
Arkansas	$5,887	$9,936				$963	166
California	136						
Colorado							
Connecticut							
Florida							
Georgia	828					414	2,518
Idaho	12					250	
Illinois	15,413	19,293	53,169	$33,063	$356	187,478	58,545
Indiana	1,329,620	2,173,267	230	75,697	1,481	21,335	11,407
Iowa	44,979	9,330	4,600	580	50	43,347	112,698
Kansas	46,222	29,219	15,062	1,032	982	29,188	20,997
Kentucky	86,977	101,224	198	17,660	397	13,186	32,511
Louisiana							
Maine							
Maryland	10,719						
Massachusetts							
Michigan	9,997					380	73
Minnesota	65,216	145,354		245	1,971	35,096	43,731
Missouri	139,416	310,276	26,601	6,170	2,928	203,672	289,999
Montana	2,653					70	6
Nebraska	448					4,088	64,824
Nevada							
New Jersey	625						
New Mexico							
New York	112,736	27,013		2,877	912	13,798	5,769
North Carolina							
Ohio	59,842	12,475	5,560	550		37,822	242,742
Oklahoma	8,692	27,731	360			1,325	22,374
Oregon							
Pennsylvania	144,424	1,258	149,079	1,465		8,730	1,745
Rhode Island							
South Dakota						600	621
Tennessee	5,965	1,685	150	275	11	910	53,726
Texas	13,144	7	6,000	1,111		2,624	21,650
Utah	23,961	1,100		200		150	8,932
Vermont	2,760					50	
Virginia	6,457					197	
Washington							
West Virginia	354					4,000	5,445
Wisconsin	40,497	3,358	2,021	12,090	5,305	30,101	101,383
Wyoming	740						
Other States	150						205
Total	2,178,870	2,873,026	278,930	153,015	14,343	639,674	1,182,451

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Value of the production of limestone in the United States in 1912 and 1913, by States and uses—Continued.

1912—Continued.

State.	Crushed stone.			Flux.	Sugar factories.	Other.	Total.
	Road making.	Railroad ballast.	Concrete.				
Alabama	$54,270	$14,093	$26,235	$339,166	.....	$60	$531,085
Arizona	.....	.....	.....	6,400	$12,450	249	19,099
Arkansas	.....	.....	50,000	.....	.....	.....	66,952
California	51,128	24,000	9,133	62,210	73,834	24,794	245,235
Colorado	.....	376	.....	313,237	46,189	5,202	365,004
Connecticut	.....	.....	1,600	1,524	.....	14,800	17,924
Florida	27,500	15,000	8,750	.....	.....	9,274	60,524
Georgia	7,385	6,000	11,500	6,636	.....	17,906	53,187
Idaho	1,131	.....	.....	.....	18,398	.....	19,791
Illinois	1,054,676	368,349	963,617	951,733	6,441	96,651	3,808,784
Indiana	1,033,673	102,841	45,197	216,275	3,152	52,162	5,066,337
Iowa	30,821	235,326	404,302	2,928	8,128	47,306	944,885
Kansas	95,642	274,176	234,261	178	.....	10,238	757,197
Kentucky	298,057	473,023	106,890	9,670	.....	20,355	1,160,148
Louisiana	.....	.....	.....	.....	.....	.....	(a)
Maine	.....	.....	.....	.....	.....	.....	(a)
Maryland	88,637	83,532	36,423	8,364	.....	1,038	228,713
Massachusetts	.....	.....	.....	.....	.....	.....	(a)
Michigan	295,449	28,368	97,298	137,812	36,944	533,237	1,139,560
Minnesota	23,410	25,642	195,545	1,235	4,400	4,785	546,650
Missouri	260,198	387,449	641,798	38,937	7,270	59,011	2,373,725
Montana	1,365	101	15,994	99,896	34,048	.....	154,133
Nebraska	.....	5,985	252,043	.....	7,308	673	335,369
Nevada	.....	.....	.....	.....	.....	.....	(a)
New Jersey	19,509	21,410	9,014	122,943	.....	31,833	235,334
New Mexico	.....	229,593	7,950	.....	.....	.....	237,543
New York	828,682	701,932	811,187	535,159	.....	168,846	3,208,911
North Carolina	10,294	.....	.....	.....	.....	29,570	39,864
Ohio	1,671,990	782,486	269,015	1,698,237	12,562	91,807	4,885,088
Oklahoma	60,862	178,440	110,035	150	.....	25	409,994
Oregon	.....	.....	.....	.....	.....	.....	(a)
Pennsylvania	490,342	285,312	407,445	4,361,677	.....	165,831	6,017,308
Rhode Island	.....	.....	.....	.....	.....	.....	(a)
South Dakota	560	.....	3,663	.....	5,184	.....	10,628
Tennessee	268,509	114,011	127,076	88,789	.....	12,222	673,329
Texas	52,753	49,956	349,602	33,094	.....	1,310	530,251
Utah	.....	.....	.....	170,642	.....	3,260	208,245
Vermont	1,875	.....	3,463	665	.....	3,831	12,644
Virginia	56,506	115,576	41,192	130,916	.....	52,225	403,069
Washington	2,255	.....	153	10,718	.....	7,244	20,370
West Virginia	24,352	292,317	87,775	546,511	.....	20,713	981,467
Wisconsin	310,151	26,726	263,626	36,219	.....	22,000	853,477
Wyoming	703	.....	4,452	.....	58,800	54	64,749
Other States	8,158	12,281	38,221	5,851	.....	8,360	73,227
Total	7,130,843	4,854,301	5,634,455	9,937,772	335,108	1,516,962	36,729,800

a Included in "Other States."

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Value of the production of limestone in the United States in 1912 and 1913, by States and uses—Continued.

1913.

State.	Rough building.	Dressed building.	Paving.	Curbing.	Flagging.	Rubble.	Riprap.
Alabama	$9,517	$27,020	$189			$188	$58,850
Arizona							
Arkansas	5,901	39,384				408	1,627
California							
Colorado							
Connecticut							
Florida							
Georgia	360		1,875			175	
Idaho						200	
Illinois	14,806	11,911	9,734	$262	$205	131,194	113,053
Indiana	1,265,323	1,842,682	2,463	73,050	1,660	7,520	19,797
Iowa	33,266	8,155	16,713	750	238	30,723	97,619
Kansas	24,112	32,879	17,280	4,198	30	13,873	95,273
Kentucky	69,673	75,230	37	6,014		4,358	73,197
Louisiana							
Maine							
Maryland	7,024	125	4,350			3,400	145
Massachusetts							
Michigan	8,274					3,511	610
Minnesota	46,477	155,592	218	750		32,408	46,838
Missouri	110,080	268,970	14,596	9,296	3,328	127,683	473,399
Montana	2,874					25	17
Nebraska	1,008					1,121	52,080
New Jersey	185						
New Mexico	250						
New York	75,278	29,737	7,750	2,861		16,600	10,594
North Carolina							
Ohio	47,127	4,587	2,650			23,187	83,358
Oklahoma	985	50,030				64	16,066
Oregon							
Pennsylvania	106,690	840	129,440	3,170	85	8,600	8,391
Rhode Island							
South Dakota	40						788
Tennessee	7,292	4,208	15,100	153		2,100	59,429
Texas	36,508	11,979	7,800	547		698	8,824
Utah	23,188	1,278				50	26,057
Vermont	665					2,500	425
Virginia	771	1,668				197	
Washington							
West Virginia			800			750	
Wisconsin	40,840		8,345	7,742	1,791	28,947	68,189
Wyoming	950						
Other States	3,600						16,768
Total	1,943,064	2,566,275	239,340	108,793	7,337	440,490	1,331,423

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Value of the production of limestone in the United States in 1912 and 1913, by States and uses—Continued.

1913—Continued.

State.	Road making.	Railroad ballast.	Concrete.	Flux.	Sugar factories.	Agricultural.	Other.	Total value.
Alabama	$47,237	$7,187	$168,195	$487,078	.....	$7,203	.....	$812,664
Arizona	.....	.....	.....	3,628	$2,700	.....	.....	6,328
Arkansas	.....	.....	4,000	.....	.....	900	.....	52,220
California	95,793	3,971	68,645	42,274	93,950	1,500	$17,154	323,287
Colorado	.....	.....	.....	333,609	93,875	.....	1,252	428,736
Connecticut	.....	.....	.....	.....	.....	.....	.....	(a)
Florida	29,749	37,500	72,432	.....	.....	16,908	.....	156,589
Georgia	17,850	6,000	17,233	7,056	.....	30,850	2,500	83,899
Idaho	43	.....	.....	.....	18,326	.....	.....	18,569
Illinois	895,352	592,210	1,245,829	979,303	2,000	78,278	38,005	4,112,172
Indiana	956,234	203,431	29,985	199,955	1,554	20,124	25,819	4,649,597
Iowa	81,351	218,573	300,767	4,866	5,900	3,089	1,672	803,682
Kansas	49,074	283,435	264,854	170	.....	1,500	37,327	824,005
Kentucky	286,407	422,864	101,948	12,368	.....	10,582	6,356	1,069,034
Louisiana	.....	.....	.....	.....	.....	.....	.....	(a)
Maine	.....	.....	.....	.....	.....	.....	.....	(a)
Maryland	116,946	94,202	28,245	23,723	.....	.....	4,081	282,241
Massachusetts	.....	.....	.....	.....	.....	.....	.....	(a)
Michigan	266,316	48,400	145,965	494,495	38,215	7,048	395,874	1,406,708
Minnesota	32,771	31,774	283,947	540	720	2,287	2,297	636,620
Missouri	338,849	405,665	623,436	35,874	3,992	8,297	62,555	2,486,020
Montana	2,312	485	11,480	230,097	13,625	.....	.....	260,915
Nebraska	.....	38,178	231,626	.....	2,274	.....	.....	326,287
New Jersey	15,377	22,800	12,579	178,233	.....	44,844	6,662	280,680
New Mexico	.....	148,016	.....	.....	.....	.....	.....	148,266
New York	1,047,216	804,296	759,814	562,669	.....	67,441	154,787	3,539,043
North Carolina	15,174	.....	339	11,269	.....	40,350	.....	67,132
Ohio	1,596,796	790,004	318,097	1,934,734	15,393	29,255	100,122	4,945,310
Oklahoma	4,384	98,134	74,102	.....	.....	60	3,087	246,912
Oregon	.....	.....	.....	.....	.....	.....	.....	(a)
Pennsylvania	585,004	419,579	531,889	4,206,797	.....	51,416	137,244	6,189,145
Rhode Island	.....	.....	.....	.....	.....	.....	.....	(a)
South Dakota	1,670	.....	1,400	.....	.....	.....	200	4,098
Tennessee	212,004	142,289	123,945	64,825	.....	9,413	2,828	643,586
Texas	138,747	132,699	218,282	29,928	.....	500	3,777	590,289
Utah	.....	.....	.....	317,316	.....	.....	118	368,007
Vermont	1,906	.....	4,225	677	.....	.....	7,317	17,715
Virginia	64,327	256,960	62,201	185,052	.....	19,236	7,620	598,032
Washington	4,630	.....	80	47,107	.....	696	10,400	62,913
West Virginia	51,129	250,062	76,202	663,892	.....	550	3,220	1,046,625
Wisconsin	391,230	74,717	329,723	42,119	.....	4,704	18,788	1,017,135
Wyoming	.....	.....	12,084	.....	95,200	.....	.....	108,234
Other States	7,787	17,964	43,595	4,335	.....	36,687	.....	130,734
Total	7,353,665	5,551,415	6,167,144	11,103,989	387,724	493,718	1,051,062	38,745,429

a Included in "Other States."

Building stone.—Over 11 per cent of the limestone output is represented by building stone, which, including both rough and dressed stone, decreased in value from $5,051,896 in 1912 to $4,509,339 in 1913, a loss of $542,557, or 10.7 per cent. Indiana and Missouri are the largest producers of building limestone, and the output of Indiana, amounting to $3,108,005, represented 68.9 per cent of the building limestone quarried in the United States. Most of the product of this State is quarried in Lawrence and Monroe counties and is well known to the trade as Bedford oolitic limestone, from the town of Bedford, Lawrence County, which, with Bloomington, Monroe County, forms the shipping center of this stone. This Bedford stone is chiefly used for building stone, although some is sold for flagstone, curbstone, monumental stone, crushed stone, ground limestone, furnace flux, and some—not included in this report—is used for lime and cement.

As this stone is so large a factor in the building limestone trade, the following tables are given to show the details of the production

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of Bedford oolitic limestone in Lawrence and Monroe counties, Ind., from 1901 to 1913 and by uses in 1912 and 1913:

Quantity and value of Bedford oolitic limestone quarried in Lawrence and Monroe counties, Ind., 1901–1913.

Year.	Lawrence County.		Monroe County.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1901	.....	$1,365,875	.....	$421,599	.....	$1,787,474
1902	.....	1,207,497	.....	439,902	.....	1,647,399
1903	.....	1,088,477	.....	487,662	.....	1,576,139
1904	.....	1,054,302	.....	589,672	.....	1,643,974
1905	.....	1,550,076	.....	843,369	.....	2,393,445
1906	.....	1,460,743	.....	1,162,062	[a] 9,282,004	2,622,805
1907	.....	1,413,280	.....	908,612	[a] 7,849,027 [b] 256,960	2,321,892 119,235
1908	[a] 5,199,996 [b] 93,085	1,498,822 42,150	[a] 3,147,097 [b] 8,260	880,218 1,719	[a] 8,347,093 [b] 101,765	2,379,040 43,869
1909	[a] 6,441,483 [b] 145,672	1,678,195 71,637	[a] 2,970,288 [b] 106,000	801,436 56,925	[a] 9,411,871 [b] 252,272	2,479,631 128,562
1910	[a] 5,778,000 [b] 131,590	1,841,233 75,906	[a] 3,960,148 [b] 70,055	1,265,287 44,224	[a] 9,738,808 [b] 202,245	3,106,520 120,130
1911	[a] 6,612,988 [b] 53,242	2,171,148 27,842	[a] 2,915,444 [b] 50,914	859,580 45,112	[a] 9,528,442 [b] 104,156	3,030,728 72,954
1912	[a] 7,066,496 [b] 71,124	2,622,648 37,894	[a] 3,375,808 [b] 76,532	824,594 60,629	[a] 10,442,304 [b] 147,656	3,447,242 98,523
1913	[a] 5,737,303 [b] 91,034	2,095,461 50,092	[a] 3,273,309 [b] 67,035	992,286 41,508	[a] 9,010,672 [b] 158,069	3,087,747 91,600

[a] Cubic feet. [b] Short tons.

Production of Bedford oolitic limestone in Lawrence and Monroe counties, Ind., in 1912 and 1913, by uses.

1912.

County.	Building.						Other uses.[a]		Total value.
	Rough.		Dressed.		Total.				
	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (short tons).	Value.	
Lawrence	4,024,487	$942,180	3,042,009	$1,680,468	7,066,496	$2,622,648	71,124	$37,894	$2,660,542
Monroe	2,182,802	361,942	1,192,946	402,652	3,375,808	824,594	76,532	60,629	885,223
Total	6,207,349	1,304,122	4,234,955	2,143.120	10,442,304	3,447,242	147,656	98,523	3,545,765
Average price	.....	$0.21	.....	$0.50	.....	$0.33	.....	$0.67	.....

1913.

Lawrence	3,881,072	$915,001	1,856,231	$1,180,460	5,737,303	$2,095,461	91,034	$50,092	$2,145,553
Monroe	1,948,892	344,097	1,324,477	648,189	3,273,369	992,286	67,035	41,508	1,033,794
Total	5,829,964	1,259,098	3,180,708	1,828,649	9,010,672	3,087,747	158,069	91,600	3,179,347
Average price	.....	$0.22	.....	$0.57	.....	$0.34	.....	$0.58	.....
Percentage of increase (+) or decrease (−) as compared with 1912	−6.08	−3.45	−2.49	−14.67	−13.71	−10.43	+7.05	−7.03	−10.33

[a] Includes stone used for rubble, riprap, curbstone, flagstone, glass making, sugar factories, ground limestone, etc.

These figures do not indicate a very thriving condition of the industry, but most of the operators report better prospects for 1914. It is

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noticeable that although the output for Lawrence County decreased, the output for Monroe County increased. The total decrease for the two counties was $366,418, or 10.33 per cent, from $3,545,765 in 1912 to $3,179,347 in 1913. Building stone decreased from 10,442,304 cubic feet, valued at $3,447,242, in 1912 to 9,010,672 cubic feet, valued at $3,087,747, in 1913, a loss of 1,431,632 cubic feet in quantity and of $359,495 in value. The average price per cubic foot increased slightly in 1913, or from 21 cents in 1912 to 22 cents in 1913 for stone in rough blocks and from 50 cents in 1912 to 57 cents in 1913 for milled stone.

Missouri ranked next to Indiana in the output of building limestone, the value of the output in 1913 being $379,050, in comparison with $449,692 for 1912, a decrease in 1913 of $70,642.

About 68 per cent of the Missouri building stone in 1913 was a strong, light-gray crystalline limestone from Carthage, Jasper County, and the following table shows the details of production in this district for the last six years:

Production of limestone at Carthage, Jasper County, Mo., in 1908–1913, by uses.

Year.	Number of producers.	Building stone.		Curbing.	Flagging.	Rubble.	Other.[a]	Total value.
		Quantity.	Value.	Value.	Value.	Value.	Value.	
		Cubic feet.						
1908	8	431,576	$280,249	$5,238	$3,602	$2,682	$17,826	$309,597
1909	8	481,274	334,715	1,263	6,232	3,791	24,001	370,002
1910	10	502,161	317,244	1,767	7,220	2,945	23,571	352,756
1911	9	427,974	293,470	2,427	2,431	2,506	23,865	324,789
1912	8	404,685	268,930	670	2,878	4,885	28,087	305,450
1913	7	346,421	236,524	.....	2,367	1,500	18,564	258,955

[a] Includes stone used for monumental work, crushed stone, stone sold to glass factories, blast furnaces, sugar factories, etc.

From this table it will be seen that the limestone production in 1913 for this district decreased $46,495, or over 15 per cent. Stone for all purposes showed a general decrease, both in quantity and value. The average price per cubic foot for building stone was 68.6 cents in 1911, 66.5 cents in 1912, and 68 cents in 1913.

Another limestone of increasing importance to the building trade in the Central States is the oolitic limestone quarried near Bowling Green, Warren County, Ky. The following table shows the quantity and value of this limestone from 1909 to 1913:

Production of limestone in Warren County, Ky., by uses, 1909–1913.

Year.	Rough building.		Dressed building.		Crushed stone.		Other.[a]	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Value.	
	Cubic feet.		*Cubic feet.*		*Short tons.*			
1909	203,120	$60,936	74,482	$62,989	46,725	$22,013	$33,704	$179,642
1910	204,602	56,141	90,100	57,350	108,183	47,532	5,584	166,607
1911	134,291	45,792	103,220	76,589	57,720	25,921	250	148,552
1912	148,711	51,638	114,308	100,774	38,495	17,563	1,890	171,965
1913	110,576	36,388	95,915	74,750	37,972	20,476	2,045	133,159
Average price.	.....	$0.33	.....	$0.77	.....	$0.54	.....	.....

[a] Curbing, flagging, fluxing, and monumental stone.

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Building stone as shown in this table represented nearly 92 per cent of the total production of limestone for building in Kentucky. Building stone in this district also suffered a decrease in output. The average price per cubic foot was 33 cents for rough stone and 77 cents for dressed stone. Stone sold as crushed stone decreased in quantity and increased in value of output.

Paving.—Limestone for paving decreased in value from $278,930 in 1912 to $239,340 in 1913, or $39,590. Pennsylvania, Kansas, Iowa, Tennessee, and Missouri produced most of the limestone used for paving in 1913.

Curbing.—There was a decrease of $44,222 in the value of the output of limestone for curbing, from $153,015 in 1912 to $108,793 in 1913. Indiana furnished almost all of this material in 1913.

Flagging.—A decrease of $7,056 marked the limestone output of flagging, from $14,393 in 1912 to $7,337 in 1913. Most of the stone was from Missouri.

Rubble.—Rubble decreased in value $199,194, from $639,674 in 1912 to $440,480 in 1913. Illinois, Missouri, Minnesota, and Iowa reported the largest production.

Riprap.—Riprap increased in value $148,972, from $1,182,451 in 1912 to $1,331,423 in 1913. Missouri, Illinois, Iowa, and Kansas produced most of this stone in 1913.

Crushed stone.—Crushed limestone used in road making, railroad ballast, concrete, etc., had a larger value than any other limestone product. In 1913 this output was 35,169,528 short tons, valued at $19,072,224, an increase of 2,046,886 short tons in quantity and of $1,452,625 in value for 1913, as compared with 1912, when the figures of output were 33,122,642 short tons, valued at $17,619,599. This was a notable increase, and the largest increase, both in quantity and in value, was shown in the stone sold for railroad ballast.

In 1913 the total output was divided into 13,296,377 short tons, valued at $7,353,665, for road making; 11,774,121 short tons, valued at $5,551,415, for railroad ballast; and 10,099,030 short tons, valued at $6,167,144, for concrete, which compared with the itemized output for 1912—road making, 13,292,935 tons, valued at $7,130,843; railroad ballast, 10,560,779 tons, valued at $4,854,301; concrete, 9,268,928 tons, valued at $5,634,455—was an increase of 3,442 tons in quantity and $222,822 in value for road making, of 1,213,342 tons in quantity and $697,114 in value for railroad ballast, and of 830,102 tons in quantity and $532,689 in value for concrete. It is possible that the stone for road making includes some stone used for concrete, some of the operators reporting that they were unable to subdivide, except approximately, their total output of crushed stone, not knowing the exact use which was to be made of the stone. The average price per short ton was 54 cents in 1913 compared with 53 cents in 1912.

Ohio, Illinois, New York, Pennsylvania, Indiana, and Missouri were ranking States in 1913 according to quantity of crushed limestone sold, and the rank according to value was Illinois, Ohio, New York, Pennsylvania, Missouri, and Indiana.

Furnace flux.—Next to crushed stone, limestone sold for furnace flux showed the largest value and a larger increase in production in 1913 than any other limestone product. The production in 1913 was 22,620,961 long tons, valued at $11,103,989; in 1912 it was

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20,190,554 long tons, valued at $9,937,772, an increase in 1913 of 2,430,407 tons in quantity and of $1,166,217 in value. The average price per ton was 49 cents in 1913, the same as in 1912. Pennsylvania, Ohio, Illinois, West Virginia, New York, Michigan, Alabama, and Colorado were the principal producers. The increase in the production of furnace flux in 1913 is comparable with the increase in pig iron manufactured in 1913.

The following table shows the production of limestone for smelter, open-hearth, and blast-furnace flux in 1912 and 1913, by States, in long tons:

Production of furnace flux, etc., in 1912 and 1913, by States, in long tons.

State.	1912		1913	
	Quantity.	Value.	Quantity.	Value.
Alabama	582,904	$339,166	841,477	$487,078
Arizona	7,035	6,400	3,596	3,628
California	54,868	62,210	39,520	42,274
Colorado	534,224	313,237	552,413	333,609
Connecticut	2,774	1,524	(a)	(a)
Georgia	11,622	6,636	10,813	7,056
Illinois	2,747,284	951,733	2,790,245	979,303
Indiana	481,900	216,275	407,414	199,955
Iowa	5,500	2,928	6,387	4,866
Kansas	177	178	241	170
Kentucky	14,527	9,670	19,117	12,368
Maine	.....	.....	(a)	(a)
Maryland	14,978	8,364	46,860	23,723
Massachusetts	(a)	(a)	(a)	(a)
Michigan	295,941	137,812	1,202,817	494,495
Minnesota	1,257	1,235	479	540
Missouri	42,533	38,937	40,757	35,874
Montana	259,193	99,896	732,017	230,067
New Jersey	230,822	122,943	330,352	178,233
New York	981,670	535,159	972,529	562,669
North Carolina	.....	.....	18,781	11,269
Ohio	3,334,126	1,698,237	3,822,762	1,934,734
Oklahoma	100	150	.....	.....
Oregon	(a)	(a)	.....	.....
Pennsylvania	8,540,211	4,361,677	8,180,056	4,206,797
Rhode Island	(a)	(a)	(a)	(a)
Tennessee	156,732	88,789	117,156	64,825
Texas	48,161	33,094	44,427	29,928
Utah	295,670	170,642	499,406	317,316
Vermont	604	665	413	677
Virginia	254,108	130,916	343,382	185,052
Washington	17,484	10,718	35,546	47,107
West Virginia	1,179,708	546,511	1,420,979	663,892
Wisconsin	83,840	36,219	85,589	42,119
Other States	10,551	5,851	5,430	4,335
Total	20,190,554	9,937,772	22,620,961	11,103,989
Average price per ton	.....	$0.49	.....	$0.49
Per cent of increase	.....	.....	12.04	11.74

a Included in "Other States."

Other uses.—Limestone reported as sold to sugar refiners increased in value from $335,108 in 1912 to $387,724 in 1913, a gain of $52,616. Stone for other uses included stone quarried and used by alkali works in New York and Michigan; stone sold to glass factories, to paper mills, and to carbonic-acid plants; stone for making whiting and mineral wool; and also a small quantity sold to farmers for burning into lime to be used as a fertilizer, it being impossible to get the lime value for this stone. The total output of stone for these various uses decreased in value $465,900, from $1,516,962 in 1912 to $1,051,062 in 1913.

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A value of $493,718 was reported as the value of ground limestone, used to spread on the soil for a soil sweetener or enricher, in the place of lime. This represents 408,627 short tons of the material and shows an average price of $1.21 per ton. In 1913 there was reported for this purpose, but included with other uses, about 200,000 tons, valued at $311,702, or $1.56 per ton. This product has only been used for three or four years. In 1911 the first record of production was made which amounted to 174,290 short tons.

SANDSTONE.

There was an increase of $139,456, or 2.02 per cent, in the value of the sandstone output in 1913; nevertheless this stone has taken a less prominent position than any other variety of stone. All the other varieties have in the last 10 years increased considerably in value of output, but sandstone has showed a decided falling off. In 1904 the total value of the output, including bluestone and quartzite, was $10,273,891; in 1913 it was $7,033,067, a decrease of $3,240,824, or over 31 per cent for the 10 years. During that same period granite increased about 21 per cent; trap rock 230 per cent; marble nearly 25 per cent; limestone about 75 per cent; and the entire stone output increased over 42 per cent.

One of the chief causes of decrease in the sandstone industry has been a strong factor in the increase of the other kinds of stone. This is the use of crushed stone, which at first was used chiefly for road making and ballast, then as an aggregate in concrete for paving, sidewalks, bridge piers, and abutments, foundations, steps, and house trimmings, which are the principal uses besides building stone for sandstone. Sandstone is not so much used for crushed stone as the other varieties of stone, and the decrease caused by the use of concrete was not made up by increased production of crushed sandstone, as with some of the other varieties of stone. Not included in the sandstone figures is the value of a considerable quantity of sandstone chiefly from Ohio and Michigan, manufactured into grindstones, scythestones, and other abrasives and included in the report on abrasives. Some sandstone is also ground into sand for glass-making and other purposes, and is included in the chapter in Mineral Resources on sand and gravel.

The value of sandstone in 1913 was $7,033,067. In 1912 it was $6,893,611. Had it not been for a decrease in the output of the sandstone known to the trade as "bluestone," quarried in eastern New York and northeastern Pennsylvania, there would have been a larger increase. The decrease in bluestone production in New York was especially noticeable and was occasioned by the curtailment or the finishing of work done by the State on public construction, as well as decreased output of the regular products. This stone forms such an important industry for these two States that a separate table is given to it. New York, Pennsylvania, and Ohio in the order named are the most important sandstone-producing States; of these Ohio was the only one showing an increase for 1913, but the increase was not considerable. Much of the sandstone reported from Minnesota, South Dakota, and Wisconsin is a quartzite, locally often called granite or jasper and used largely for paving.

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The following table shows the value of the sandstone production in the United States from 1909 to 1913, inclusive, by States:

Value of sandstone (including quartzite and bluestone) production in the United States 1909–1913, by States.

State.	1909	1910	1911	1912	1913
Alabama	$77,327	$109,063	$73,195	$27,596	$151,111
Arizona	298,335	131,716	[a] 57,100	21,524	88,391
Arkansas	67,956	71,641	85,529	80,238	89,395
California	290,034	113,488	176,213	70,724	139,486
Colorado	197,105	189,603	135,673	108,169	96,964
Connecticut	[b]	[c]	[a]	[d]	[d]
Florida	.....	.....	[a]	[d]	[d]
Georgia	.....	.....	.....	[d]	[d]
Idaho	29,263	34,070	40,097	13,883	20,111
Illinois	26,891	5,710	30,953	32,720	28,781
Indiana	4,119	4,141	7,078	[d]	[d]
Iowa	2,443	14,456	56,312	1,551	1,612
Kansas	19,560	25,691	13,774	6,031	1,602
Kentucky	90,835	90,729	97,439	114,650	81,171
Maryland	10,584	18,226	10,097	15,950	16,435
Massachusetts	[b] 457,962	[c] 424,485	[a] 406,072	307,838	188,919
Michigan	36,084	31,233	12,985	16,438	19,224
Minnesota	299,358	483,578	292,366	349,063	315,149
Missouri	28,763	39,398	19,748	15,004	10,195
Montana	73,443	59,019	34,437	33,280	51,061
Nebraska	.....	.....	[a]	[d]	[d]
Nevada	[b]	[c]	.....	.....	.....
New Jersey	189,098	112,650	155,765	166,583	69,584
New Mexico	4,963	1,402	4,065	[d]	66,700
New York	[e] 1,430,830	[e] 1,810,770	[e] 2,353,995	[e] 1,651,317	[e] 1,568,952
North Carolina	.....	[c]	[a] 10,385	[d]	[d]
North Dakota	[b]	.....	.....	.....	.....
Ohio	1,639,006	1,402,131	1,334,947	1,312,300	1,316,028
Oklahoma	59,855	19,801	90,971	5,334	1,010
Oregon	[b] 4,811	[c] 30,375	[a] 1,668	.....	[d]
Pennsylvania	[e] 1,637,794	[e] 1,595,070	[e] 1,333,309	[e] 1,367,601	[e] 1,359,533
South Dakota	[b] 118,029	156,576	141,615	139,167	163,165
Tennessee	[b]	[c]	[a]	[d]	[d]
Texas	61,600	40,471	28,000	82,501	58,750
Utah	71,235	43,589	41,953	32,562	23,965
Virginia	28,574	25,080	31,315	4,020	[d]
Washington	335,470	438,581	301,843	344,476	560,468
West Virginia	[b] 201,038	[c] 212,308	203,935	183,410	146,698
Wisconsin	204,959	189,654	144,430	179,352	213,229
Wyoming	13,130	5,314	3,584	3,730	[d]
Other States	.....	.....	.....	206,299	185,358
Total	8,010,454	7,930,019	7,730,868	6,893,611	7,033,067

[a] Arizona includes Florida; Massachusetts includes Connecticut; Oregon includes Nebraska; North Carolina includes Tennessee.

[b] Massachusetts includes Connecticut; Oregon includes Nevada; South Dakota includes North Dakota; West Virginia includes Tennessee.

[c] Massachusetts includes Connecticut; Oregon includes Nevada; West Virginia includes Tennessee and North Carolina.

[d] Included in "Other States."

[e] Includes bluestone.

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Value of production of sandstone (including quartzite and bluestone) in the United States in 1912 and 1913, by States and uses.

1912.

State.	Rough building.	Dressed building.	Ganister.	Paving.	Curbing.	Flagging.	Rubble.
Alabama			$45				$4,856
Arizona	$924	$2,700				$200	300
Arkansas	1,205	350		$4,032	$5,905	2	4,776
California	34,338	3,668			2,845		588
Colorado	14,154	23,023	14,278	25,955	8,362	4,289	4,547
Connecticut							
Florida							
Georgia							
Idaho	11,630	2,063					49
Illinois	644	564	2,250				135
Indiana							
Iowa	818	14					104
Kansas	5,063				42	926	
Kentucky	23,071	59,492		140		1,118	5,350
Maryland	6,500		5,250	2,400			530
Massachusetts	70,038	76,725					
Michigan	4,844	9,985					1,132
Minnesota	7,591	52,695		180,894	17,074		6,320
Missouri	1,921	4,078			40	100	1,375
Montana	725	23,554				2,144	2,777
Nebraska							
New Jersey	55,609	49,665		925	7,670	450	2,854
New Mexico							
New York	74,392	300,098		226,581	530,980	325,577	18,259
North Carolina							
Ohio	122,248	389,899	4,000		337,110	278,887	28,432
Oklahoma	1,600	17					3,717
Oregon							
Pennsylvania	221,467	239,424	206,728	31,634	189,696	100,339	38,442
South Dakota	23,619	18,440		29,413			2,669
Tennessee							
Texas	147				994		
Utah	5,966	13,146		5,500		2,837	4,613
Virginia							500
Washington		67,532		40,201			1,826
West Virginia	76,034	20,620			6,577	1,400	20,189
Wisconsin	10,249	28,675	47,384	37,100			10,322
Wyoming	2,049						
Other States [a]	83,417	16,599	10,000	500	1,250	2,800	35,692
Total	860,263	1,403,026	289,935	585,275	1,108,545	721,069	200,305

[a] Includes Connecticut, Florida, Georgia, Indiana, Nebraska, New Mexico, North Carolina, and Tennessee.

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Value of production of sandstone (including quartzite and bluestone) in the United States in 1912 and 1913, by States and uses—Continued.

1912—Continued.

State.	Riprap.	Crushed stone.			Other.	Total.
		Road making.	Railroad ballast.	Concrete.		
Alabama	$10,685			$12,000		$27,596
Arizona		$2,250	$13,000	2,150		21,524
Arkansas	26,500	2,341	18,867	16,486	$80	80,538
California	43	20,832	228	6,204	2,066	70,724
Colorado	3,619	8,600		1,349		108,169
Connecticut						(a)
Florida						(a)
Georgia						(a)
Idaho	150					13,883
Illinois		29,127				32,720
Indiana						(a)
Iowa	40			575		1,551
Kansas						6,031
Kentucky	2,014	21,000		2,465		114,650
Maryland	1,250					15,950
Massachusetts	1,975	33,600		125,500		307,838
Michigan	140				337	16,438
Minnesota	540	8,935		69,655	5,340	349,063
Missouri	4,280	2,240		125	845	15,004
Montana	2,015				2,065	33,280
Nebraska						(a)
New Jersey	792	8,000		37,529	3,059	166,583
New Mexico						(a)
New York	5,685	9,659	1,118	131,808	27,160	1,651,317
North Carolina						(a)
Ohio	90,189	3,310	5,000	36,252	16,973	1,312,300
Oklahoma						5,334
Oregon						(a)
Pennsylvania	34,200	81,656	94,079	107,588	22,348	1,367,601
South Dakota	10,491	3,600		50,935		139,167
Tennessee						(a)
Texas	9,360			72,000		82,501
Utah					500	32,562
Virginia		1,450	1,800	270		4,020
Washington	234,915					344,476
West Virginia	5,858	3,088	36,554	13,080	30	183,410
Wisconsin	25,241	11,370		9,006	5	179,352
Wyoming				1,681		3,730
Other States [b]	5,855	30,356		16,916	2,914	[b] 206,299
Total	475,837	281,414	170,646	713,574	83,722	6,883,611

[a] Included in "Other States."
[b] Includes Connecticut, Florida, Georgia, Indiana, Nebraska, New Mexico, North Carolina, and Tennessee.

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Value of production of sandstone (including quartzite and bluestone) in the United States in 1912 and 1913, by States and uses—Continued.

1913.

State.	Rough building.	Dressed building.	Ganister.	Paving.	Curbing.	Flagging.	Rubble.
Alabama	$37,500						99,055
Arizona	2,275	$8,520					7,156
Arkansas	325			$2,035	$8,240	$39	1,039
California	7,514	69,220		16,000	435		1,050
Colorado	10,808	23,746	$10,353	31,509	9,995	2,068	2,931
Connecticut							
Florida							
Georgia							
Idaho	12,979	6,859					223
Illinois	428	120	2,000				22
Iowa	500	450			6		80
Indiana							
Kansas	916					322	364
Kentucky	16,022	56,135				1,264	80
Maryland	450		782	1,480			3,805
Massachusetts	34,068	30,111					1,574
Michigan	5,580	7,380					3,125
Minnesota	1,379	47,629		184,573	9,863		7,808
Missouri	2,070	2,839		185	74		970
Montana	3,992	44,139					800
Nebraska							
New Jersey	32,848	5,487		325	350	450	1,520
New Mexico	800	200					11,700
New York	65,254	212,000		288,648	525,209	211,047	9,326
North Carolina							
Ohio	102,413	345,638	4,200		450,839	239,675	11,616
Oklahoma							1,000
Oregon							
Pennsylvania	188,986	210,192	283,056	49,174	144,725	95,479	70,744
South Dakota	17,179	19,377		65,708			708
Tennessee							
Texas	4,200						
Utah	1,861	4,073		15,659			2,372
Virginia							
Washington	1,410	58,626		20,672			5,240
West Virginia	25,347	27,663		12	3,800	660	11,871
Wisconsin	10,478	23,261	63,384	60,287		13	23,928
Wyoming							
Other States	64,205	5,522	13,000	500	1,300	2,092	10,164
Total	651,837	1,209,087	376,775	736,707	1,154,836	553,129	200,822

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Value of production of sandstone (including quartzite and bluestone) in the United States in 1912 and 1913, by States and uses—Continued.

1913—Continued.

State.	Riprap.	Road making.	Railroad ballast.	Concrete.	Other.	Total value.
Alabama	$17,056			$87,500		$151,111
Arizona	60,240				$10,000	88,391
Arkansas	32,205	$18,053	$14,468	12,925	75	89,395
California	813	28,680	2,524	7,830	5,420	139,486
Colorado	12	5,000		522		96,964
Connecticut						(a)
Florida						(a)
Georgia						(a)
Idaho						20,111
Illinois		25,988		213		28,781
Iowa	38			538		1,612
Indiana						(a)
Kansas						1,602
Kentucky	5,003			2,667		81,171
Maryland	2,698				7,220	16,435
Massachusetts		45,000		77,866		188,919
Michigan	3,127				12	19,224
Minnesota		12,343		46,300	5,254	315,149
Missouri	57	4,000				10,195
Montana	50				2,100	51,081
Nebraska						(a)
New Jersey	4,648	11,375		10,288	2,293	69,584
New Mexico				54,000		66,700
New York	19,676	7,301	44,437	165,175	20,879	1,568,952
North Carolina						(a)
Ohio	82,862	1,638	16,586	39,471	21,090	1,316,028
Oklahoma					10	1,010
Oregon						(a)
Pennsylvania	28,126	106,533	71,240	103,543	7,735	1,359,533
South Dakota	12,423			47,230	540	163,165
Tennessee						(a)
Texas	10,750	6,250		37,500		58,750
Utah						23,965
Virginia						(a)
Washington	474,520					560,468
West Virginia	23,507	4,753	34,282	14,053	750	146,698
Wisconsin	2,873	20,145		8,114	746	213,229
Wyoming						(a)
Other States	32,500	3,383	2,506	46,024	4,262	185,348
Total	813,184	300,442	186,043	761,759	88,386	7,033,067

a Included in "Other States."

Building stone.—The largest product of the sandstone industry is building stone, and this showed a decrease of $402,365, or more than 17 per cent. The value in 1913, including rough and dressed stone, was $1,860,924; in 1912, $2,263,289. Ohio, Pennsylvania, and New York produced most of the building stone.

Ganister.—Ganister reported from Pennsylvania, Wisconsin, Georgia, Colorado, Ohio, Illinois, and Maryland was valued at $376,775 in 1913, an increase of $86,840 over 1912.

Paving.—The total value of the paving stone (blocks, slabs, etc.) increased $151,492—from $585,275 in 1912 to $736,767 in 1913. New York and Minnesota were large producers.

Curbing.—Sandstone for curbing was valued at $1,108,545 in 1912; in 1913 its value was $1,154,836, an increase of $46,291. New York, Ohio, and Pennsylvania were the principal producers.

Flagging.—Ohio, New York, and Pennsylvania were the chief States producing sandstone flagging, and this product was the only one besides building stone that declined in value of output. The total decrease amounted to $167,940—from $721,069 in 1912 to $553,129 in 1913.

Rubble.—The value of rubble remained practically the same—$200,822 in 1913 and $200,305 in 1912.

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Riprap.—Sandstone sold for riprap increased in value from $475,837 in 1912 to $813,184 in 1913, a gain of $337,347. Over half of this output was produced in Washington and was used for the protection of the Northern Pacific Railway tracks in the vicinity of Tacoma.

Crushed stone.—There was an increase in value in crushed sandstone of $82,610—from $1,165,634 in 1912 to $1,248,244 in 1913. The quantity increased from 1,568,020 short tons in 1912 to 1,580,966 tons in 1913, a gain of 12,976 tons. The average price per ton in 1912 was 74 cents; in 1913 it was 79 cents.

BLUESTONE.

A fine-grained, compact dark blue-gray argillaceous sandstone is quarried in eastern and southeastern New York and in northeastern Pennsylvania. The figures of production for this stone are included in those of sandstone, but on account of the local importance of the material, the value is also given separately. This stone is marketed under peculiar conditions. Almost all the owners of land in this district have small deposits of the stone on their property and quarry small quantities of it annually, which they sell to agents of large dealers who market the stone. As many of these dealers also quarry the stone, it has been found that the best figures of production are obtained from the dealers, who are better able to give the entire quantity of stone bought and sold than are the small producers. This stone is used chiefly for flagging, curbing, and for sills, lintels, steps, and house copings. In recent years, however, much of this stone for these purposes has been replaced by cement concrete. For the last few years some of this stone has been crushed and used in the concrete work of the New York City water-supply system. The output in 1913 was valued at $1,280,862, in 1912 at $1,505,763, a decrease of $224,901, or 14.9 per cent, in 1913.

The following table shows the value of the bluestone produced from 1906 to 1913:

Value of bluestone produced from 1906 to 1913.

Year.	Value.	Year.	Value.
1906	$2,021,898	1910	$1,535,187
1907	2,117,916	1911	1,876,473
1908	1,762,860	1912	1,505,763
1909	1,446,402	1913	1,280,862

The following table shows the value and uses of the bluestone produced in New York and Pennsylvania in 1912 and 1913:

Value and uses of bluestone produced in New York and Pennsylvania in 1912 and 1913.

1912.

State.	Building purposes.	Flagging.	Curbing.	Crushed stone.	Other purposes.	Total value.
New York	$310,797	$325,210	$404,203	$102,905	$9,187	$1,152,302
Pennsylvania	114,296	95,223	116,647	9,593	17,702	353,461
Total	425,093	420,433	520,850	112,498	26,889	1,505,763

1913.

New York	$201,032	$200,588	$327,694	$199,210	$15,775	$944,299
Pennsylvania	118,988	93,198	94,625	23,306	6,446	336,563
Total	320,020	293,786	422,319	222,516	22,221	1,280,862

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STONE RESOURCES IN THE STATES WEST OF THE ROCKY MOUNTAINS.

QUARRY MAPS.

Within the last few years the United States Geological Survey has received many requests for maps showing areas of stone suitable for building and other purposes in the United States. Such a set of maps is doubtless very desirable, and their preparation may be considered a goal to be attained at some future time, but not under present conditions, as the preparation of such a publication would entail an expense not compatible with the funds at present available. The compilation of a reconnaissance geologic map of the United States, recently issued, occupied the time of a geologist for several years. This geologic map shows, for the most part, the rocks subdivided on the basis of age—not on a lithologic basis—and therefore, in order to make it a serviceable stone map, it would be necessary so to resubdivide and reclassify all the cartographic units that the character and accessibility of the rock might be indicated, a task which would require many years of additional work in field and office. This reconnaissance geologic map of the United States is now available; it is contained in the geologic map of North America, issued as part of Survey Professional Paper 71,[1] in 1912, and may be obtained free of charge from the Director of the United States Geological Survey, Washington, D. C. This map shows on a scale of approximately 80 miles to 1 inch the main subdivisions of rocks by geologic systems, and in some places by series, but it does not show the rock formations, such as limestones, sandstones, granites, etc., that are suitable and available for quarry products. The Survey has issued, from time to time, special reports on certain types of stone within limited areas, as, for instance, on granite in certain States, on marble or limestone, or structural materials in general in certain districts; and occasionally a note on stones suitable for building purposes is included in a geologic folio text; but, taken altogether, the work done on this subject is hardly more than begun. In most of the States, especially those east of Mississippi River, the locations of the stone quarries already opened outlined in a general way the areas underlain by suitable stone, although, of course, suitable stone may extend far beyond the areas actually developed. Markets and transportation are the two factors that exert the greatest influence on the development of stone, even though the stone may be admittedly of an excellent quality and may be in a convenient position for quarrying. With all these limitations in mind, it was decided that the most practicable maps bearing on the stone industry that could be prepared by the Survey in the short time available for the work should indicate the locations of quarries by classes of stone. Accordingly maps having a scale of approximately 40 miles to 1 inch showing quarries throughout the United States by classes of stone have been completed. Sections comprising the States east of Mississippi River were published in the report on stone in Mineral Resources for 1911, and sections comprising the States west of Mississippi River to and including the Rocky Mountain States were issued with the report on stone in Mineral Resources for 1912. The final sections comprising the quarries in the States west of the Rocky

[1] Willis, Bailey, Index to the stratigraphy of North America: U. S. Geol. Survey Prof. Paper 71, 894 pp., 1 wall map, 1912.

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Mountains are included in the present report on the stone industry in 1913. The statements in this chapter with regard to the ages of the rocks under discussion have been made with reference to the classification and geologic mapping in Professional Paper 71. Many facts are also drawn from State reports and other sources credited in the footnotes, and notes made by the writers in the course of visits to quarries in the western States have also contributed to the data. If these stone-quarry maps are studied in connection with the geologic map of the United States mentioned above, many interesting, economic, and scientific relations between the stone industry and areal geology may be observed.

A few notes in general explanation of the maps should be included here. It was the aim in the preparation of these maps to present an outline of quarry areas in so far as practicable without special reference to the magnitude of the output of stone from any given area. For instance, if there are many quarries at or near one place it is impracticable on account of the scale of the maps to represent each quarry by a separate symbol, and only one symbol is given; on the other hand, in an isolated place there may be but one quarry and that a small one, yet the fact that quarriable stone occurs at that place has been regarded as the important point to be brought out by these maps, and the isolated quarry is therefore indicated by the appropriate symbol. Naturally, where the quarry industry predominates in a county or a district these maps readily indicate that fact, as inspection of Plates V, VI, and VII shows at a glance that there are several granite quarries near Rocklin, Cal., many trap-rock quarries in the vicinity of San Francisco, Cal., and Portland, Oreg., and several limestone quarries in Sanpete County, Utah, but equally interesting and possibly of even more importance to the matter of distribution of stone resources is the demonstration that there is also quarriable granite in Baker County, Oreg., limestone in Blaine County, Idaho, volcanic tuff in Cochise County, Ariz., and marble in Stevens County, Wash. A provision has been made in the directories accompanying the maps which shows the number of quarries represented by a single symbol. For instance, with regard to granite symbol No. 18, on the map of California, Plate VI, the directory gives "18—Rocklin (24)"—indicating that 24 granite quarries are represented by the single granite symbol near Rocklin, Cal. The limestone quarrying industry and the manufacture of lime are so intimately associated, practically every lime manufacturer at times selling some crushed stone or other form of stone not burned and many stone producers making lime as an adjunct to their stone business, that the locations of limekilns have also been given on these maps, by simply modifying the triangular limestone symbol into a double triangle which indicates "limestone and limekiln." On the other hand, limestone quarries operated as a source of material for the manufacture of cement have not been included, because, as a rule, they are operated solely for cement material, the sale of stone from them being negligible. Besides this, the location of cement plants has been shown on maps accompanying the chapters on the cement industry in Mineral Resources for 1910 and 1911.

The advisability of giving a complete tabulation of such chemical analyses of stones as are available has been considered; but, since analyses of stones other than limestones are of rather doubtful value,

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except from a scientific viewpoint, this matter has been disposed of by giving in the chapter in Mineral Resources on the production of lime in 1911,[1] a few copies of which are still available for free distribution, an extensive tabulation of chemical analyses of both limestone and limes from all parts of the country, including both high-calcium and high-magnesian materials. In a few instances, however, both chemical and physical data with regard to rocks of particular interest have been included in the present report.

Under marbles no distinction has been made in the quarry symbols between true metamorphic marbles and crystalline limestones susceptible of a high polish, since the latter class includes some very valuable marbles of commerce. Onyx marble in Arizona and California is also indicated by the marble symbol.

The preparation of these quarry maps was begun in 1911 on the basis of the Survey's list of stone producers in 1910. Before the chapters for 1911 and 1912 went to press some revision was made in order to bring the maps up to date, and the maps for the 1913 chapter have been completely revised, but it has been unavoidable to include some quarries now inactive, and probably it has been impossible to include every place in which stone is quarried. However, the first fault is not a disadvantage, because, although a quarry may have been abandoned temporarily, it by no means follows that the quarriable stone has been exhausted, and the symbol stands not wholly to show the location of a quarry but also the existence of a certain type of stone at that place.

There are certain limitations to the accuracy of these maps which should be mentioned here. The scale of the maps is approximately 40 miles to 1 inch. On this scale the quarry symbols, which have been made as small as is compatible with convenient reading and interpretation, are still so large that each one covers much more area than an average-sized quarry. Where quarry areas are close together, it has therefore been necessary to place the symbol as near the determined locality as possible, without running the symbols together or superimposing one upon another. In the great majority of counties the only town shown on the base map is the county seat. Therefore the location of all other places where quarries are situated has been of necessity interpolated from other Government maps, commercial atlases, and railroad maps. Not all these maps are agreed in all details, and many of the locations resulting from comparisons of these various sources of information are to some extent compromises. One other unavoidable source of error is that the exact location of a quarry may not have been given by the stone producer in his reports to the Survey. All quarries have therefore been plotted with reference to the nearest railroad station or post office, according to the reports of the producer, unless, as in many cases, special information in the possession of the writers has been drawn upon to determine doubtful locations. In view of the small scale of the map and the purposes which it is intended to fulfill it is believed that these errors will not detract seriously from its value.

The treatment of the subject in the following discussions has, on account of limitations of time and space, been more or less generalized, although the present chapter treats of the stone resources of the sev-

[1] Burchard, E. F., The production of lime: U. S. Geol. Survey Mineral Resources for 1911, pt. 2, pp. 658-707, 1912.

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eral States concerned in much greater detail than have previous chapters. In the case of the directories locations only have been given, without reference to ownership of quarries, since it is planned to treat this subject in an entirely impersonal way, and also because the ownership of quarries changes more or less frequently.

Readers who are interested in further details concerning the stone resources of the country will find much local information in the Survey reports listed in the bibliography at the end of this chapter, especially the works of Dale and Watson, and in a textbook by G. P. Merrill, "Stones for building and decoration," published by John Wiley & Sons, New York.

ARIZONA.

By E. F. Burchard.

The stone resources of Arizona, which are comparatively little developed, comprise granite, basalt, tuffs, and other igneous rocks, slate, marble, onyx, limestone, and sandstone. Sedimentary rocks predominate in the northeastern third of the State, although there are in this portion many areas of volcanic rocks. Across the middle of the State from northwest to southeast extends an irregular belt of volcanic, intrusive, and metamorphic rocks. The southern portion of the State is largely covered by "desert wash," a more or less loosely consolidated deposit which partly fills the desert basins, and through which protrude many isolated areas of igneous and a few areas of sedimentary rocks. The sedimentary beds of the northern and northeastern parts of the State range in age from the Algonkian sandstone and limestone of the Grand Canyon to the Upper Cretaceous sandstone and shale of the plateau country in Navajo and Apache counties, although there are breaks in the sequence of the deposits. These sedimentary rocks consist of sandstone, shale, and limestone, and contain also important beds of gypsum.

Granite.—Granite and related rocks occur in several widely separated areas in Arizona. According to the geologic folios [1] that have been published by the United States Geological Survey, granites occur in the Bradshaw Mountains, at and near Prescott, in the Mule Mountains near Bisbee, in the mountains surrounding Globe, and in the vicinity of Clifton. According to Blake [2] there is a broad central area of coarse-grained porphyritic granite, generally gray in color, outcropping in the Santa Rita Mountains at Helvetia; on the east side of the Huachuca Mountains facing the San Pedro Valley; in the northern end of the Santa Catalina Range near Oracle; and extending northward toward the Superstition Mountains and to Salt River east of Florence. Blake states that in the Tombstone area gray medium-grained granodiorite occurs which weathers in such a way as to leave large globular masses or bowlders of disintegration confusedly piled on the surface. Another outcrop on a large scale of similar granodiorite is found in the Dragoon Mountains. Quartz diorite is available in inexhaustible quantities in the Bradshaw Mountains.

[1] Geol. Atlas, folios 111, 112, 126, 129.
[2] Blake, Wm. P., Geology of Arizona: Rept. Governor of Arizona to the Secretary of the Interior, for 1903, pp. 131–132.

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The granite output of Arizona is not large at present and is confined chiefly to supplying local demands for monumental work and for an occasional building. Quarries are situated near Phoenix, Maricopa County; Globe, Gila County; and Prescott, Yavapai County.

The quarries near Phoenix are about 7 miles south of the city. Two varieties of granite are produced here, both gneissoid. The finer grained of the two is of a gray color and is noticeably porphyritic, with white crystals of orthoclase in contrast to the finer-grained gray mass of the rock. The coarser-grained variety is of lighter color and with biotite having a linear arrangement. A local light-gray granite, resembling the latter of these two, has been used in the walls of the first story of the State Capitol at Phoenix.

The quarries near Prescott are 1½ to 2 miles northwest of the city on the north side of the Santa Fe, Prescott & Phoenix Railway tracks and about one-fourth of a mile from a siding where blocks may be loaded for shipment. The rock is obtained from large bowlders, which form a low ridge. These bowlders are of all sizes up to 30 feet in diameter, and represent the residual portions of the rock that lay between the joint planes. Weathering along the joint planes and exfoliation of the blocks have reduced the surface granite generally tc a bowldery condition. The surface of the bowlders is oxidized to a light pink color, which extends generally to a depth of only one-eighth to one-half inch, and below which the color of the granite is light gray. The grain of the stone is medium and fairly even. Small faint, light-brown spots are scattered uniformly through the mass. These spots appear to be stains in the quartz and feldspar grains, produced by the oxidation of minute specks of iron pyrite. Pyrite is not common in this granite, however, and the staining appears to have reached its maximum. This granite polishes fairly well, but does not show a marked contrast between hammered and polished surfaces. It is reported to work favorably and to possess good rift and grain. Conditions in this vicinity do not favor opening quarries in the rock below the bowldery zone, and since the bowldery material is fairly satisfactory, besides being cheaply quarried, it is probable that it will continue to be utilized as a source of granite for several generations.

A gray, partially disintegrated granite is quarried about 2 miles east of Dome, Yuma County, for use as railroad ballast.

A crystalline andesite porphyry, termed commercially "white granite," and a granodiorite, or "black granite," are found in the Santa Rita Mountains, about 5 miles northeast of Helvetia, Pima County.[1] The andesite porphyry occurs as a nearly perpendicular dike about 100 feet thick cutting granite. The material is strong and durable and of low specific gravity.

Dark volcanic rocks.—There are vast areas of basaltic lava flows in Arizona, mostly of Tertiary and later age. They are found in all parts of the State and are associated with the sedimentary rocks as well as with granites, schists, and tuffs. Locally they are termed "malpais" rocks. From an economic viewpoint this type of rock is of very little importance at present in this area. Because of its somber colors and its rough texture it does not make a desirable building and ornamental stone, and, although it makes good crushed

[1] Personal communication from C. F. Tolman, jr., Palo Alto, Cal.

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stone for concrete and railway ballast, it is not yet in great demand for these purposes. An interesting type of basaltic rock is obtained from bowlders about 12 miles north of Phoenix which is worked into rough blocks for foundations and is also trimmed into dimension blocks for fireplaces and mantels. This rock is of a brownish-purple color, of medium grain, is rather vesicular, and contains calcite in many of the small cavities. A dark-gray, more or less vesicular basalt is associated with the red sandstone near Flagstaff, and production of basalt has been reported from the vicinity of Kingman. Basalt is also quarried in a small way from surface material a few miles southwest of Tucson.

Light volcanic rocks.—The most common rocks of this type that are quarried for structural purposes in the Western States are tuffs of various kinds, and Arizona is most bountifully supplied with them. Tuff is generally well suited to building purposes in arid, warm regions, and where it can be used it possesses advantages over other kinds of stone in its lightness of weight and in the ease and cheapness with which it may be quarried and trimmed. Generally it is possible to quarry tuff in blocks as large as are needed. Evidence of the appreciation of the value of tuff as a building stone in Arizona is shown by the opening of tuff quarries in such widely scattered parts of the State as Kingman, Flagstaff, Kirkland, Phoenix, Tempe, Tucson, Huachuca, and Tufa, near Douglas. The tuff near Kingman[1] is fawn-colored or mouse-colored, with small fragments of white or cream-colored pumice stone. The rock is largely composed of pumice, and contains also grains of transparent sanidine. The material is obscurely stratified, and, although soft enough to be readily cut with a saw or other tools in any direction, it does not crumble and is strong enough for ordinary building purposes. The specific gravity is 1.72; the weight per cubic foot, 107.36 pounds; and the absorption is 23¼ per cent.

Rhyolite tuff and rhyolite porphyry are quarried within 2 to 5 miles west and southwest of Tucson, mostly from surface and bowlder material. According to Blake, the principal varieties are white and pink in color, the white variety having no perceptible rift, so that it cuts or chips well in any direction. Some inclusions are present which detract from the homogeneity of the stone. The university dormitory and several residences and terrace walls in Tucson are built of the white tuff. The pink tuff consists largely of silica. It possesses a uniform, pleasing rose-pink tint, and has fewer inclusions than the white tuff. This rock breaks with a conchoidal fracture equally well in any direction, can be easily cut and chiseled, yet is firm and strong. The rock has a specific gravity of 2.55, and the weight per cubic foot is 159.17 pounds, which is greater than that of most tuffs. The absorption is less than the normal, being only a little more than 5 per cent. The tuff from near Phoenix is reported as a friable variety,[1] of white and gray color, sufficiently compact to be cut in blocks of considerable size, and to have been used to some extent for building purposes. The form of occurrence is reported to be in "blankets," 3 to 15 feet thick, more or less tilted, and the constituent material to be mainly pumice fragments of about 0.25 millimeter in greatest diameter.

[1] Blake, Wm. P., Rept. Governor of Arizona for 1899, p. 131, 1899.

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A light-gray rhyolitic tuff is quarried from bowlders 5 or 6 miles east of Flagstaff, near Cliffs station. This is a granular and rather porous rock, not very hard, but blocks of it are capable of being trimmed evenly on the edges. Locally it is called "malpais." It has been used in many of the older buildings of Flagstaff, including the post-office block, a bank, several business buildings and residences, and it is used considerably at present as a foundation stone.

The tuff quarried near Kirkland is, when fresh, of an attractive cream shade which weathers to pinkish buff. The groundmass is soft, being composed in large part of pumice, but there are small inclusions of dark crystalline material that are much harder than the surrounding rock. These inclusions, or "knots," render the rock less desirable to work than a more homogeneous material would be, and since they come out easily they produce a slightly pitted surface in dimension stone. Notwithstanding this disadvantage, this tuff was used for the exterior of the upper two stories of the State capitol at Phoenix. Five columns and six pilasters, each with carved capital and base, were cut from the tuff. The ornamental blocks about the windows and cornices are sawed, while the walls are mainly of rock-faced tuff. The tuff stonework surmounts and harmonizes well with the gneissoid granite which was used to the top of the basement story. This capitol is a fine example of what may be done with tuff as a building stone in the southwestern United States.

One of the most promising deposits of tuff in Arizona is situated about 2 miles northwest of the station of Tufa on the El Paso & Southwestern Railroad. This rock has a fine-grained, stony groundmass in which a few small bright phenocrysts of feldspar may be seen, and a very few inclusions or knots of coarser textured material as much as three-fourths of an inch in diameter. The rock is all of a light shade, but there are various pleasing tints developed from place to place in the deposit, such as white, cream, light blue, pink, and light brown. The rock is rather soft and breaks easily in the quarry, but is reported to harden in the walls of buildings. It appears to trim evenly, and also is fully as susceptible of tooling and carving as a fine-grained sandstone. A favorite way of finishing the stone for trimming is to rub it to a plane surface. The deposit is extensive and is reported to cover 100 acres or more in this vicinity. It appears to have been deposited on an eroded surface, and is in places 25 feet or more in thickness. In places the surface is bare, but in others there is a little soil or gravel. At one place a few inches of tuffaceous sandstone was noted overlying the tuff.

The tuff from near Tufa is practically the only natural building stone that has been used in the city of Douglas and vicinity. Foundations, trimmings, and walls of business blocks, churches, and residences are built of this rock, and it is reported to have been shipped to El Paso and other cities.

Rhyolite occurring in a large bluff on the west side of the river near Clifton[1] has been used for building purposes. Dacite, which occurs in inexhaustible quantity and in a readily accessible situation near Globe,[2] affords an easily worked and durable material and has

[1] Lindgren, Waldemar, U. S. Geol. Survey Geol. Atlas, Clifton folio (No. 129), p. 13, 1905.
[2] Ransome, F. L., U. S. Geol. Survey Geol. Atlas, Globe folio (No. 111), p. 17, 1904.

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been used locally for walls and foundations. The green rhyolite tuff which occurs abundantly in the valley of Castle Creek, Yavapai County, has been used in building the hotel at Castle Creek Hot Springs.[1] This stone is said to be soft and easily worked when fresh and to harden on exposure. It is considered a handsome building stone.

Slate.—According to Blake [2] large areas of mica slate and clay slate occur in Arizona in the pre-Cambrian rocks in the mountainous region from the Yuma ranges to the Bradshaw Mountains; in an extensive region of argillaceous slate on Cave Creek, Maricopa County; near Walnut Grove in Yavapai County; and on the eastern side of the Rincon Mountains, about 6 miles north of Dragoon Summit station. This last slate occurs in close association with the gneissic rocks in which the quartz veins carrying wolframite occur.

One slate quarry is reported as operated occasionally about 7 miles north of Phoenix. The product resembles a mica schist rather than a slate, and is used chiefly for foundations. The foundation of the State Capitol is reported to have been built of this rock.

A large part of the Yavapai schist as mapped in the Bradshaw Mountains folio is reported to consist of phyllites with slaty cleavage, but they are not known to be of sufficiently fine and even grain nor to have sufficiently perfect cleavage to be properly termed slates. No records of the use of this rock for roofing purposes are available.

Marble.—Notes are available concerning many deposits of marble in Arizona, and it is apparent that there is no lack in this State of suitable marble of various shades, or of onyx. A variety of types is found in one locality about 5 miles northeast of Helvetia,[3] in the Santa Rita Mountains, Pima County, including fine and coarse grained black marble, fine and coarse grained dark blue marble, and coarse-grained white marble. Blake [4] mentions marble from this locality having been used at Tucson for monumental purposes, and also states that remarkably fine white statuary marble occurs in large masses on Marble Peak on the northeast side of the Santa Catalinas. Three areas of calcite marble on the east side of the Chiricahua Mountains are described by Paige.[5] Two of the areas lie about 14 miles S. 22° E. from Bowie, a station on the Southern Pacific Railroad, and the third lies about 18 miles N. 50° W. of Rodeo, N. Mex., a station on the El Paso & Southwestern Railroad, and about 5 miles northwest of Paradise, Ariz. The two marble deposits that can be reached from Bowie lie, one just west of Fort Bowie and the other about 3 miles east of the same place. The western deposit is of medium-grained, crystalline-granular structure, and is mostly of a pure white color with pinkish tones. Thin seams of red iron oxide are abundant but enhance rather than decrease the beauty of polished surfaces. On the borders of the ledge gray and blue shades are developed. This rock is severly fractured at the surface and had not been sufficiently prospected when examined in 1908 for its real worth to be determined. The marble east of Fort Bowie is a massive, even, crystalline-granular

[1] Jaggar, T. A., jr., and Palache, Charles, U. S. Geol. Survey Geol. Atlas, Bradshaw Mountains folio (No. 126), p. 11, 1905.
[2] Blake, Wm. P., Geology of Arizona: Rept. Governor of Arizona for 1903, pp. 127–128.
[3] Personal communication from C. F. Tolman, jr., Palo Alto, Cal.
[4] Blake, Wm. P., Rept. Governor of Arizona for 1899, p. 132.
[5] Paige, Sidney, Marble prospects in the Chiricahua Mountains, Ariz.: U. S. Geol. Survey Bull. 380, pp. 299–311, 1909.

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medium-grained aggregate of calcite crystals. Its dominant color is white, or pinkish, or grayish white, with irregular black markings. Gray, dove-colored, and blue varieties also are present, and some is pure white. The marble zones are metamorphic developments in limestone strata, and in places contain siliceous bands, which must be avoided in quarrying, running parallel with the stratification of the limestone. The joints vary in abundance and distribution and are far enough apart in places to permit good bodies of rock to be quarried. The most southern area of the three examined by Paige lies near the head of Whitetail Canyon. The ledge can be traced for a mile and is a band in a series of northwest-southeast trending Carboniferous (?) limestones. This is a coarsely crystalline-granular white marble without markings. A few limonite stains are present and silica bands are abundant in places, although thicknesses of stone, respectively 100 feet and 50 to 60 feet, were observed to be free of this impurity.

Tests made on marble samples from near Fort Bowie at the structural materials laboratory of the Survey at St. Louis show an average strength of 10,300 pounds per square inch; weight ratio of absorption, 0.0011; volume ratio of absorption, 0.0029; and weight per cubic foot, 168.91 pounds. Considerable marble is reported to have been shipped from this quarry for use in a recently constructed Federal building.

Marble deposits of great variety and beauty are reported to occur 2 miles southeast of Dragoon station. White marble, golden-yellow marble, and marble veined with green, yellow, and other shades, all of fine grain, as well as conglomerate showing marked contrasts of color, are among the samples sent to the Survey from this deposit. All of these samples are susceptible of a high polish. Undeveloped, coarsely crystalline marbles are reported to occur in the Colorado River region south of the mouth of Williams River, and it is understood that some prospecting has been done about 10 miles north of the station of Bouse.

Onyx marble.—Some of the onyx deposits in Arizona are already well known. Near Mayer, on the left bank of Bigbug Creek, about 26 miles southeast of Prescott, is a deposit of onyx marble reported to cover about 200 acres, small portions of which are of a quality suitable for decorative purposes, although but little commercial exploitation has yet been possible. This deposit varies from 1 foot to 25 feet in thickness. The material is variable in color and texture. Most of it is white or pale green where fresh, but oxidation of iron contained in ferrous carbonate has produced brown limonite and deep red hematite, and these minerals in the form of powder are suspended in the calcite, giving brilliant color contrasts with the white or green material. Lack of space prohibits extended description of this material here, but the interested reader will find detailed discussions in the references cited below.[1]

A second deposit of onyx marble in Yavapai County is in the southern part of the county at Cave Creek, about 45 miles northeast of Phoenix.[2] The prevailing colors of this onyx are similar to those at

[1] Merrill, G. P., U. S. Nat. Mus. Rept., 1893, pp. 539–585; Stones for building and decoration, 3d ed., pp. 263–266, Wiley & Sons, 1903.
Blake, Wm. P., Rept. Governor of Arizona for 1899, pp. 132–133.
Jaggar, T. A., jr., and Palache, Charles: U. S. Geol. Survey Geol. Atlas, Bradshaw Mountains folio (No. 126), pp. 3 and 11, 1905.
[2] Blake, Wm. P., op. cit., p. 133. Merrill, G. P., op. cit., pp. 266–267.

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Mayer, viz, greenish and yellowish with veins of brown and red, and are said to be very beautiful. The onyx used in the counter of the Annex Hotel in Chicago is reported to have been produced from the deposit at Cave Creek. This deposit is intimately associated with basalt, and is more or less shattered, so that it has been difficult to extract large blocks of material of fine quality.

One more important deposit of onyx marble in Arizona remains to be mentioned, that situated in Santa Cruz County, about 4½ miles south of Greaterville, Pima County. This deposit is found in a cave which has been developed in limestone in Cave Hill on the east side of the Santa Rita Mountains. According to Willis,[1] this onyx marble is travertine, of considerable homogeneity of texture and of color. The color is brown of various shades, and it is reported that cracks in the material are so rare that the size of blocks that are obtainable is limited only by the equipment that may be installed to handle the stone and by the transportation facilities.

In addition to these deposits Blake mentions samples of black and white banded onyx having been brought to Tucson from some place in Arizona, but neglects to state the exact locality.

Limestone and lime.—Two extensive limestone formations of Carboniferous age, the Redwall limestone and the Kaibab limestone, occur in north-central Arizona, and to the south large masses of limestone, in large part Carboniferous and Devonian in age, have been infolded among the intrusive and sedimentary rocks of the mountainous districts. The Redwall limestone is reported to range from 800 to more than 2,000 feet in thickness, but includes much calcareous shale and some sandstone. The Kaibab limestone is generally about 800 feet thick where fully developed, but contains considerable chert in its upper portion. Lime is burned and crushed stone is produced in places from the Carboniferous limestone in northern Arizona, as at Flagstaff, Puntenney, and Delrio. In the Clifton-Morenci district the upper 100 feet of the Modoc limestone is composed of limestone carrying about 95 per cent of calcium carbonate. Near Morenci a nearly pure dolomite underlies this limestone. The limestone is quarried for smelter flux on Modoc and Shannon mountains. In the Bisbee district the Escabrosa limestone would probably yield stone suitable for crushing and possibly of fair quality for building. The Naco limestone is quarried for flux near the smelters, and there is a vast supply of limestone suitable for this purpose in this district.

Sandstone.—The principal areas of sandstone in Arizona in which quarries have been opened are in the northern part of the State along the Atchison, Topeka & Santa Fe Railway, but there are other localities where sandstone or quartzite is quarried, as, for example, near Globe. Near Haviland, Mohave County, a tuffaceous sandstone is reported to be quarried. Probably the best-known sandstone of Arizona is that quarried about 1½ miles east of Flagstaff. This is a fine, angular-grained stone of several dull shades of light red. Calcium carbonate and argillaceous material are readily detectable in the cementing material. According to Merrill [2] the stone contains 79.19 per cent silica and insoluble matter, 3.75 per cent iron and aluminum oxides, and 13.11 per cent calcium carbonate. The stone is only moderately hard. About 65 feet of sandstone are exposed in the

[1] Willis, C. F., Arizona (magazine published at Phoenix), pp. 14–15, November, 1913.
[2] Merrill, G. P., op. cit., p. 516.

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vicinity of the quarry, besides about 25 feet of shaly sandstone and sandy shale. The rock has been included by Darton[1] in the Moencopie formation, probably of Permian age. Below the shaly layers, which are in the upper part of the exposure and which show laminations of color, the sandstone is mainly massive and of a uniform shade. Two sets of nearly vertical joints are prominent, but their spacing is wide enough to permit the quarrying of good-sized blocks. Much of the red sandstone from Flagstaff is used in California cities. Among the buildings in which it may be seen are the Federal buildings in Sacramento and Los Angeles. The stone can be sawed and tooled readily, but does not seem capable of retaining sharp lines and angles for long periods.

About 3 miles south of Flagstaff a light-gray sandstone has been quarried to a small extent for local use. This is a stone of very pleasing shade. The grains are subangular to round, and there are a few flakes of mica visible. The rock contains a little calcium carbonate, but not so much as the red stone. But little has been produced thus far on account of the long haul necessary.

The red sandstone of the Moencopie formation has been quarried also at three places farther east along the line of the Santa Fe Railway, viz, at Sunshine, Winslow, and Penzance. The stone at Sunshine is very similar to that at Flagstaff. It is used for masonary dams, riprap, foundations, and general building work. South and east of Winslow there are beds of a lighter red color than at Flagstaff that have been quarried in a small way, and on the northwest edge of the town several shaly buttes are capped with reddish-brown flaggy sandstone, a little harder than the light-red stone. This flaggy stone has been used for sidewalks, curbs, retaining walls, foundations, and to some extent for walls of buildings. The stone at Penzance is also of a reddish shade and has been used for purposes similar to those of the stone at Sunshine.

In the vicinity of Bisbee rough blocks have been quarried from the Bolsa quartzite and used chiefly for foundations and walls. The stone is said to be hard and durable but not to be suitable for cut-stone work. About 1½ miles east of Globe, in Rocky Gulch, some beds of red quartzitic sandstone belonging to the Apache group have been quarried to a small extent for building stone. Dark-brown, banded quartzite belonging to the Coronado quartzite has been quarried about three-fourths of a mile south of Morenci and used in the construction of large buildings in the town and also for lining copper converters.

Production.—The total production of stone in Arizona in 1913 was valued at the quarries at $107,989, as compared with $67,124 in 1912.

Directory.—Quarries of all the kinds of rock quarried in Arizona are listed below by class of rock, county, and town (or post office):

[1] Darton, N. H., Reconnaissance of parts of New Mexico and Arizona: U. S. Geol. Survey Bull. 435, Pl. I, 1910.

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Directory of stone quarries in Arizona.

GRANITE.

Gila County: 1. Near Globe (in Russell Gulch).
Maricopa County: 2. Phoenix (2).
Yavapai County: 3. Prescott.
Yuma County: 4. Dome (about 2 miles east of).

DARK VOLCANIC ROCK (BASALT, ETC.).

Maricopa County: 1. Phoenix (12 miles north of).
Mohave County: 2. Kingman (near).

LIGHT VOLCANIC ROCK (TUFF, ANDESITE, RHYOLITE, ETC.).

Cochise County:
1. Huachuca.
2. Tufa.
Coconino County: 3. Flagstaff (6 miles east of).
Gila County:
4. Roosevelt.
5. San Carlos.
Maricopa County:
6. Phoenix (near).
7. Tempe (near).
Mohave County: 8. Kingman
Pima County:
9. Tuscon (near).
10. Tuscon (6 miles southwest of).
Yavapai County: 11. Kirkland.

SLATE.

Maricopa County: 1. Phoenix (about 7 miles north of).

MARBLE AND ONYX.

Cochise County:
1. Bowie (2) (12 miles southeast of).
2. Dragoon (2 miles southeast of).
3. Paradise (5 miles northwest of).
Gila County: 4. Globe (10 miles west of, at foot of Sleeping Beauty Mountain).
Pima County: 5. Helvetia (6 miles northeast of).
Santa Cruz County: 6. Greaterville (4½ miles south of) (onyx).
Yavapai County:
7. Cave Creek.
8. Mayer.
Yuma County: 9. Bouse (10 miles north of).

LIMESTONE.

Cochise County:
1. Lee.
2. Charleston (near).
Maricopa County: 3. Phoenix (2) (near).
Yavapai County:
4. Humboldt.
5. Delrio (near).

LIMESTONE AND LIME KILNS.

Coconino County: 1. Flagstaff (2).
Yavapai County:
2. Puntenney.
3. Nelson.

SANDSTONE.

Coconino County:
1. Flagstaff (1½ miles east of).
2. Flagstaff (3 miles south of).
3. Sunshine.
Gila County: 4. Globe (2).
Mohave County: 5. Haviland.
Navajo County:
6. Penzance.
7. Winslow.

UTAH.

By G. F. Loughlin.

The writer has visited only a few of the quarries in Utah and is indebted to Prof. F. J. Pack of the University of Utah, and to certain stone companies for much of the brief information here presented. It is hoped that a more thorough account can be given later.

Utah is divided geologically into three sharply contrasted parts. The western half of the State consists almost entirely of the Great

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Basin Ranges, which are composed for the most part of Paleozoic quartzite and limestone cut and overlain in places by Tertiary volcanic rocks. The Wasatch Mountains, which mark the east boundary of the Great Basin, are also composed mostly of Paleozoic quartzite and limestone overlain in places by Mesozoic strata, with local bodies of pre Cambrian rocks, and in the Cottonwood region of a large intrusive granite body of probably late Cretaceous age. The formations of the Wasatch Mountains are continued eastward along the Uinta Range. The southeastern quarter of the State is composed almost entirely of Mesozoic, largely sandstones with local developments of gypsum and salt, and include the important coal beds. The northeastern quarter, with the exception of the Uinta Range, is almost entirely covered with early Tertiary conglomerates and sandstones. Tertiary volcanic rocks are well distributed over the western half of the State, and are especially abundant in the southwestern part.

Granite.—Granite and closely associated rocks have been quarried both from pre Cambrian exposures and from the late Cretaceous intrusive body of the Cottonwood region, but only the latter has been worked on anything like an extensive scale. The quarries at Willard and Ogden have furnished gray to pink and red granite or granite gneiss largely from bowlders for local use, including monument bases. The exposures in places are badly shattered and streaked with pegmatite ("giant granite") veins and greenish seams of epidote and chlorite, and even moderately good quarry sites are very few. This statement holds true for the pre-Cambrian exposures along both the northern and the southern parts of the Wasatch Mountains.

The biotite granite of the Cottonwood region was first quarried at Wasatch in Little Cottonwood Canyon to furnish stone for the Mormon Temple in Salt Lake City. It has also been quarried near Alpine and Midway. Diorite, closely associated with the granite, is quarried to some extent for monumental stone on the west side of Clayton Peak near the head of Big Cottonwood Canyon. There are two quarries at Wasatch in Little Cottonwood Canyon. The older quarry is composed mostly of large glacial bowlders, the stone is gray to pale pinkish, coarse grained, and porphyritic, with feldspar crystals ranging from less than half an inch to 2 inches in length. Black inclusions, composed largely of hornblende, are prominent in the quarry, and may be seen in dressed blocks of the stone used in Salt Lake City; for example, in the steps of the post-office building. The newer quarry, situated on the north side of the canyon, is in a coarse, but more evenly grained gray to pinkish stone, and is said to be freer from the black inclusions. Stone from this quarry has been used for the main body of the new State capitol in Salt Lake.

Light and dark volcanic rocks.—Although volcanic rocks, including rhyolites, andesites, basalts, and other less commonly known types, are widely distributed throughout a great part of the State and occur in large quantities, they have been quarried only to a very small extent. The only quarry of which the United States Geological Survey has any record is at Beaver. The rock quarried there, and known by some as the "Beaver granite," is a porphyritic rhyolite of green and brown colors, with feldspar phenocrystals up to half an inch or more in length.[1]

[1] Oral information by Prof. F. J. Pack, Salt Lake City, Utah.

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There are no data at hand on the quarrying of dark volcanic rocks. Crushed stone for road building and concrete aggregate has been derived largely from limestone and quartzite. The convenient location of these rocks with respect to the larger cities and the unfavorable location of basalt or other volcanic rock of suitable quality for road building has evidently prevented the development of the latter.

Slate.—According to Eckel,[1] deposits of slate believed to be of workable extent and good quality have been described as occurring on the islands in Great Salt Lake.

The only locality on which there is more definite information is in Slate Canyon, about 2 miles southeast of Provo. This is described by Eckel as follows:

> The slate here covers a considerable area, but that exposed at the surface is so badly broken up that large slabs can not be obtained. It is possible, however, that this condition will disappear if the deposits are worked deeper. Deposits of slate believed to be of workable extent and of good quality, have been described as occurring on the islands in Great Salt Lake, and some attempt has been made to develop them.
>
> The Provo deposits furnish green and purple slates, the latter being apparently present in greater quantity. The green slates show little tendency to cleavage in their surface outcrops, and will probably be less satisfactory for roofing purposes than the purple. The green slates rub very smooth, however, and would make good slabs or mill stock if obtainable in masses of sufficient size.
>
> The purple slates split well, with a surface about as smooth as that of Peach Bottom slate (of Pennsylvania and Maryland). From samples seen it appears that they also bear punching well.

The following is a partial analysis of a sample of the purple slate, collected by Eckel and analyzed by W. T. Schaller of the United States Geological Survey:

Silica (SiO_2)	54.05	Magnesia (MgO)	9.12
Alumina (Al_2O_3)	20.95	Carbon dioxide (CO_2) and water (H_2O)	3.90
Iron oxides (Fe_2O_3 and FeO)	.28		
Lime (CaO)	0.28		

Of 36 slate analyses discussed by Eckel, this one quoted is lowest in the percentages of silica and magnesia and is very far below the average in lime.

Marble.—Limestones of more or less crystalline texture are very abundant throughout the western half of the State, especially among Paleozoic and also among Mesozoic and early Tertiary formations, but by far the greater part of them are of dark monotonous color and would probably be of unattractive appearance, even with well-polished surfaces. At certain localities, however, especially where the limestones have undergone recrystallization without the development of metamorphic silicate minerals, near intrusive contacts of granite or monzonite, outcrops may be found where the texture, color, and composition of the stone are well suited for building and decorative purposes. The deposit near Newhouse in Beaver County is one of this type and lies on both the north and the south sides of a granite (quartz monzonite) intrusion. The best exposure is said to be about 2 miles southeast of Newhouse. It is a brecciated marble, whose colors in some beds vary from white to gray, with intermediate mottled and banded varieties, and in other beds from pink to red, the latter of very beautiful appearance.[2]

[1] Eckel, E. C., in Dale, T. N., Slate deposits and slate industry of the United States: U. S. Geol. Survey Bull. 275, p. 89, 1906; Bull. 586, p. 119, 1914.

[2] Oral information from Prof. F. J. Pack.

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There is said to be a large mountain of marble at Ibapah near the southwest corner of Tooele County, remote from any railroad lines, but no further information regarding the deposit is at hand.

At Pelican Point on the west shore of Utah Lake, and near Five Mile Pass, 5 miles southwest of Fairfield in Tooele County, are prospects of black marble of Carboniferous (upper Mississippian) age. The stone is said to be rather soft, but to take a brilliant polish, yielding polished surfaces even blacker than the famous Belgian black marble. It is easily accessible and occurs in well-defined beds, which dip westward at a low angle and range in thickness up to 8 or 10 feet.[1]

An attempt was made in recent years to develop a deposit on the northern fork of Logan River, about 30 or 35 miles northeast of Logan; but the high cost of transportation and of development work in so isolated a place rendered the enterprise a failure. A little of the stone was shipped, and a sample may be seen in a small public drinking fountain on Main Street, Logan, close by the Eagle Hotel. The stone is of whitish color, irregularly mottled and streaked with reddish material.

East of the southern Wasatch Mountains, the early Tertiary formations include an impure limestone full of large oölitic concretions up to an inch or two in diameter. Marble quarries in this formation have been opened in Hobble Creek, 7 miles east of Springville and about 1 mile east of Clinton station, which is 5 miles south of Thistle Junction. The deposit at Springville is said to cover 1,200 acres, to average 200 feet in thickness, and to afford blocks of any desired size. Its colors vary from deep brown, through light brown, to straw color, and from pink to red. The variation in color is almost entirely in the cementing material, the nodules or concretions maintaining a brown color.[1]

The stone from the Clinton quarry, judging from material seen in Salt Lake City, is of prevailingly brown color, and the nodules in it are less abundant and irregularly distributed. Stone from this quarry commercially known as "bird's-eye marble," has been furnished for the interior of the Farmers & Stockgrowers Bank and the interior of the new State capitol in Salt Lake City.

Onyx marble.—"Onyx marble," or travertine, has been quarried at Pelican Point on the west shore of Utah Lake and at a point in Tooele County about 4 miles due south of Low station on the Western Pacific Railway and 60 miles west of Salt Lake City. Other prospects have been reported from Bull Valley in Washington County and from Redmond in Sevier County.

The deposits at Pelican Point consist of a series of veins, varying from a few inches to 10 and even 20 feet in thickness, cutting Carboniferous limestone.[1]

The colors of stone include dark and light amber, chrome yellow, lemon, orange, dark buff, and white. According to Merrill,[2] the stone is beautifully translucent and the colors are of astonishing depth and brilliancy. The stone may be seen in the interior of the City and County Building, Salt Lake City.

The deposit south of Low station, Tooele County, consists of a series of north-south vertical veins, ranging in width up to as much as 300 feet and in total length to 4,500 feet. The stone is said to be free from excessive fracturing and to occur in a series of vertical

[1] Oral information from Prof. F. J. Pack.
[2] Merrill, G. P., Stones for building and decoration, p. 274, 1903.

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bands which present a great variety of colors and textures. Colors range from flaky whites, through creams, pinks, and lavenders, to yellows, shaded with brown, the lighter colors predominating. Banded and beautifully clouded varieties are also present.[a] In view of the scarcity of desirable "onyx marble" in the United States, this unusually large deposit seems worthy of the attention of marble dealers.

There are two quarry properties in the district, one embracing the bulk of the deposits and the other containing a vein 4 to 8 feet thick. Stone from the latter property is being furnished for the new State capitol in Salt Lake City.

Limestone.—With limestone so abundant throughout much of the State, only deposits within short distance of commercial centers have been worked to any extent. The Paleozoic limestones comprise a considerable quantity of argillaceous limestones relatively low in lime, and large quantities of magnesian or dolomitic as well as of high calcium limestones. They are prevailingly of dark bluish color, but drab and light ash-gray colors are also conspicuous, and textures vary from dense to finely and occasionally coarsely crystalline. The dolomitic limestones are commonly finely crystalline, but texture alone is not a certain means of identification. The high-calcium limestones vary from dense to coarsely crystalline.

The quarries in Paleozoic limestone are mostly located near the larger towns along the Wasatch Range, from the Idaho boundary southward to Santaquin. Both magnesian and high-calcium rocks have been burned, but relatively few analyses of the rocks burned are available. At Smithfield and Logan, in the north, bowlders have been broken and burned for lime. Little or no rock there has been quarried from the ledge. No analyses of the rock or the burned product have been reported, and it is not known whether the lime is of reasonably uniform composition or not. The rock seen by the writer in that district is of dolomitic appearance. In Ogden Canyon bluish-black Cambrian limestone from beds just above the Cambrian quartzite is burned for lime. The limestone burned at Morgan is bluish gray and finely crystalline rock of Carboniferous age. The limestone at Devils Slide is quarried principally for Portland cement manufacture, but a small amount is used as needed for local road building. Its composition varies as shown in the following analyses, all of which are well within the limits required of ingredients in Portland cement, but are of rather low grade for lime burning.

Analyses of limestone from Devils Slide, Utah.[b]

	1	2	3	4	5	6	7
Silica (SiO_2)	8.02	31.96	6.20	7.18	27.90	25.20	12.08
Alumina (Al_2O_3)	2.29	7.97	4.00	4.04	3.16	11.32	6.48
Ferric oxide (Fe_2O_3)	.63	3.45			9.84		
Magnesia (MgO)	2.45	2.57	1.66	2.81	2.41	3.12	3.00
Lime (CaO)	46.62	26.63	47.98	46.21	29.23	30.47	41.87
Carbon dioxide (CO_2)	39.05	26.06	[c] 39.57	[c] 39.51	[c] 26.68	[c] 29.10	[c] 35.95
Total	99.06	98.64	99.41	99.75	99.22	99.21	99.38

[a] Condensed from a report by Prof. F. J. Pack.

[b] Analyses made for Union Portland Cement Co. of Ogden, Utah—Nos. 1 and 2 by company chemist, Nos. 3 to 7 by F. H. Rouk; 3–4, "High rock;" 5–6, "Low rock;" 7, "Straight rock."

[c] Loss by ignition.

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No less than 11 quarries have been operated at different times in the vicinity of Salt Lake City. The rocks quarried are in part or wholly of Paleozoic though some may be of Mesozoic age. The principal quarries are in the foothills just to the north of Salt Lake City, and in Mill Creek and Parley Canyon. The following table shows that samples analyzed of the Mill Creek and Parley Canyon quarries are of high calcium composition, whereas those of the Salt Lake City quarry represent beds of both high calcium and high magnesia rock.

Analyses of limestone near Salt Lake City.

	1	2	3	4	5	6
Silica (SiO_2)	1.00	3.00	1.20	2.60	.....	2.50
Magnesia (MgO)	15.00	.....	13.00	.....	.....	1.20
Lime (CaO)	32.00	53.00	38.80	53.00	.....	49.20
Carbon dioxide (CO_2)	[a] 52.00	[a] 44.00	[a] 47.00	44.40	.....	[a] 47.10
Magnesium carbonate ($MgCO_3$)	.....	.....	.....	.....	2.00	.....
Calcium carbonate ($CaCO_3$)	.....	.....	.....	.....	98.00	.....
Total	100.00	100.00	100.00	100.00	100.00	100.00

[a] By difference.

Nos. 1 to 4, Langton Lime & Cement Co., Crossman & Nichols, analysts.
No. 5, Union Lime & Stone Co., R. H. Officer & Co., analysts.
No. 6, Utah Lime & Cement Co.

At Provo a bluish-gray limestone of probable Cambrian age is burned for lime in the foothills just east of the city. About 1½ miles west of Santaquin in Utah County, limestone, also of probable Cambrian age, is quarried for use in sugar refining, and limsetones of Carboniferous age were formerly quarried for the same purpose near Lehi, Utah County, and at Topliff, Tooele County. The following analyses of these rocks have been made, and illustrate the composition of limestone suitable for use in beet-sugar manufacture:

Analyses of limestone from Utah and Tooele counties, Utah.

	Santaquin.				Topliff.	Lehi.
	1	2	3		4	5
Insoluble	2.88	2.77	3.00	Insoluble	2.70	0.45
Soluble silica	.12	.22		Silica	.....	.....
Alumina and ferric oxide	.60	.40	.....	Alumina and ferric oxide	.22	.15
Magnesia	1.31	.68	.....	Magnesium carbonate	.65	1.06
Lime	53.10	53.70	54.00	Calcium carbonate	96.01	96.00
Sulphuric anhydride (SO_3)	.06	.04	.....	Moisture	.12	.08
Ignition loss	42.64	42.60	43.00	Sulphur	.....	.12
				Undetermined	.30	.70
Total	100.71	100.41	100.00	Total	100.00	98.65
Calcium carbonate	94.82	95.89	97.00			

Paleozoic limestones are, or have been, quarried for smelter flux at the west side of the East Tintic range near Topliff, Rush Valley, and Doremus stations in Tooele County and at Mammoth in Juab County. The stone at the first three localities is of Carboniferous and that at Mammoth is of Cambrian age.

The rock quarried and burned along the east side of San Pete Valley from Ephraim to Manti is white, or nearly white, oolitic limestone of Eocene age. No analyses of it have been reported. The

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same stone is also quarried for use in building and may be seen in the Mormon Temple at Manti, in the central building of the University of Utah, and in several private dwellings in Salt Lake City. A considerable quantity has also been shipped to San Francisco, Cal. The stone is of creamy white texture and soft, composed of fine oolitic particles in an abundance of cementing material. The rubbed or tooled surfaces are nearly pure white. It appears well suited for interior work similar to that for which the well-known Caen stone of France has been used. Its exterior use should probably be limited to regions of mild climate.

Bowlders of a Tertiary oolitic limestone, locally called sandstone, were formerly worked at Collinston, Box Elder County, for monument bases, but none have been worked for several years.

Sandstone.—The sandstones of Utah which have been worked for more than local use are the Nugget sandstone of Mesozoic (Jurassic or Triassic) age, quarried in Emigration Canyon, around Park City, in Diamond Fork Canyon, and at Thistle, and a sandstone of Tertiary (Eocene) age quarried near Kyune station, which is about 5 miles east of Colton on the Denver & Rio Grande Railroad.

Two varieties are quarried in Emigration Canyon about 12 miles east of Salt Lake City. The more common variety is light reddish brown, banded with lines of darker brown, and very fine grained. It is a rather porous rock, composed mostly of quartz grains in a cement colored by ferric oxide, and it emits a rather pronounced argillaceous odor. It occurs in layers up to 2 or 3 feet in thickness, and blocks 10 feet or more in length can be obtained; but most of the dressed blocks seen in buildings are a foot or less in thickness and less than 3 feet in length. The stone has been used in several buildings in Salt Lake City and good examples may be seen in dwellings in the eastern part of the city.

The other variety quarried in Emigration Canyon is of light-gray to pale-buff color, but sometimes designated as "white." Its beds vary from a few inches to 5 feet in thickness, and blocks measuring as much as 10 to 15 feet in length, 5 to 10 feet in width, and 5 feet in thickness have been loosened; but, as in the red sandstone, small blocks greatly predominate. The stone is of uniform fine grain and is composed of quartz grains cemented with silica and a little clay. A little ferric oxide is also present, giving faint yellowish-brown bands in some places, and in others a more uniform buff color.

Several years ago, red sandstone belonging to the Nugget sandstone and generally similar to that in Emigration Canyon was quarried just east of Salt Lake City in what is now the Fort Douglass Reservation. This sandstone is displayed in several of the older buildings in Salt Lake City. During the few years after these quarries were included in the reservation and before those in Emigration Canyon were opened, red sandstone belonging to the Nugget sandstone was quarried, chiefly for Salt Lake City trade, a few miles north of Park City. At present the principal quarrying near Park City is at Metropolitan Spur, about 2 miles northwest of Park City. The material is light gray to reddish siliceous Nugget sandstone, occurring in thin beds 5 to 6 or more inches in thickness, and is used principally for paving blocks and flagstones in Salt Lake City.

The sandstone at Diamond Fork Canyon in Utah County is of brown rather than red color. Specimens from Thistle, Utah County, are red,

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fine, even grained, and their cementing matter contains more or less argillaceous material. Some contain small greenish-gray spots where ferric oxide is locally absent. They resemble in this respect the Portage entry, Michigan, sandstone.

The sandstone of Tertiary age quarried near Kyune station, about 5 miles east of Colton, in Utah County, is gray with a faint purplish tint, medium to fine grained, and consists of quartz with considerable feldspar and white and black mica. The mica flakes are the more prominent on surfaces parallel to bedding planes. Small dark brownish mud flakes are occasionally present. This stone is represented in the city and county building of Salt Lake City.

Production.—The total production of stone in Utah in 1913 was valued at $415,471, as compared with $249,782 in 1912.

Directory.—Quarries of all kinds of rock quarried in Utah are listed below by class of rock, county, and town (or post office).

Directory of stone quarries in Utah.

GRANITE.

Box Elder County: 1. Willard.
Salt Lake County:
2. Claytons Peak.
3. Little Cottonwood Canyon (2).
Utah County: 4. Alpine.
Wasatch County: 5. Midway.
Weber County: 6. Ogden.

LIGHT VOLCANIC ROCKS.

Beaver County: 1. Beaver.

SLATE.

Utah County: 1. Provo.

MARBLE.

Beaver County: 1. Newhouse.
Tooele County:
2. Ibapah.
3. Low (4 miles south of).
Utah County:
4. Clinton.
5. Pelican Point.
6. Five Mile Pass.
7. Springville.

LIMESTONE.

Beaver County: 1. Greenville.
Box Elder County: 2. Deweyville (2).
Juab County: 3. Mammoth.
Morgan County: 4. Devils Slide.
Tooele County:
5. Doremus.
6. Rush Valley.
Utah County: 7. Santaquin.

LIMESTONE AND LIMEKILNS.

Beaver County: 1. Beaver.
Box Elder County: 2. Geneva.
Cache County:
3. Logan.
4. Smithfield.
Iron County: 5. Cedar City (2).
Morgan County: 6. Morgan.
Salt Lake County: 7. Salt Lake City (11).
San Juan County: 8. Grayson (2).
Sanpete County:
9. Ephraim (3) and Sanpete.
10. Manti.
11. Spring City (Mill City).
Sevier County: 12. Richfield.
Tooele County: 13. Topliff.
Utah County: 14. Provo.
Wasatch County:
15. Midway.
16. Myton.
Weber County:
17. North Ogden.
18. Ogden.

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SANDSTONE.

Beaver County: 1. Beaver.
Cache County: 2. Paradise.
Grand County: 3. Moab.
Iron County:
4. Cedar City.
5. Parowan (Kane Springs).
Juab County: 6. Cooper (Mount Nebo).
Salt Lake County: 7. Emigration Canyon (2).
Summit County: 8. Park C
Uinta County: 9. Vernal.
Utah County:
10. Diamond Fork Can
11. Colton (Kyune sta
12. Thistle.
13. Thistle Junction.

CALIFORNIA.[1]

By G. F. Loughlin.

The Coast Range and the Sierra Nevada contain a vas of various kinds of stone suitable for building, but large are ranges are too remote from transportation lines to be of importance. A comparison of the quarry map (Pl. VI) w logic map of California will show that, although the diffe of stone are widely distributed, most of the quarries are the vicinity of railroads within reasonable distances from cities.

The stone-producing formations of California comprise Paleozoic (?), Jurassic, Cretaceous, and Tertiary ages, an both intrusive and effusive igneous rocks of different kin stones, limestones, marbles, and slates.

Granite.—The granites and related rocks of California greater part of the central and southern parts of the Sierra and of the Coast Range southeast of Los Angeles. Smaller considerable areas are found in the Coast Range near San Lui east and west of the lower part of Salinas River, near Santa C at several places in the Klamath Mountains in the northwes of the State. The granites of California are nearly all of dark gray color, some with a pale pinkish tint. There are and red granites similar to those of the Northeastern State certain Central States. Some, of dark-bluish to black color granites in the geologic sense, but monzonites, diorites, and They are known commercially, however, as "blue grani "black granite." Many of the light-colored granites are g rites and quartz monzonites, strictly speaking, but their di from true granite are usually microscopic. All gradations and composition may be found from light-gray true granite t or "black granite," but the darker varieties are quarried o limited extent. In texture the granites vary from very fine t grained, the medium to rather coarse grained varieties grea dominating. A favorable feature common to most of the is their remarkably good rift and grain, which allows large b be split evenly with a minimum amount of labor. Another which seems especially characteristic of California granites quantity of stone quarried from large residual bowlders, not

[1] Folios Nos. 3, 5, 11, 15, 17, 18, 31, 37, 39, 41, 43, 51, 66, and 138 of the Geologic Atlas of the U describe the geologic distribution of the different formations in the eastern half of California fro southward to Mariposa. Folio No. 101 describes the geology around San Luis Obispo, and Fo the geology from Santa Cruz northward to Redwood. Much of the information on the buildi California has been taken from Bulletin No. 38 of the California State Mining Bureau (The and industrial materials of California), by L. E. Aubury.

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local but for more extensive use. These bowlders represent the remnants left from prolonged disintegration of large granite masses, but after removal of a thin weathered coating, they yield sound stone.

The most important quarry districts are in Madera, Placer, Riverside, and San Diego counties.

At Raymond, in Madera County, are two large quarries of biotite muscovite granite which have furnished stone for the post office, the Fairmont Hotel, the Mercantile Trust Co., and other buildings, and for the Dewey and McKinley monuments in San Francisco. The principal granites used in San Francisco are those from Raymond, Rocklin, and Penryn. Granite from the latter two localities, which are in Placer County, may be seen in the State Capitol at Sacramento, and in the Hibernia Bank and the Crocker Building in San Francisco. Most of the 24 quarries at Rocklin are small, though the largest in 1904 had a depth of 100 feet. They all are said to lie within an area not more than a mile square. The stone is of light-gray color and of medium to rather coarse grain. Quartz is abundant, more so than in most of the California granites, in colorless rounded grains. Soda-lime feldspar as a rule is dominant over the potash variety, and is of opaque, white color, giving contrast to the quartz. Black mica, the only other conspicuous mineral, occurs for the most part in fine unaltered scales. Where weathered it has yielded small quantities of iron oxide, which may appear as yellowish brown specks or may have filtered into the cleavage cracks of the translucent potash feldspar grains, giving them a pale flesh-colored tint. This color, however, is too slight to affect noticeably the general gray color of the stone. The stone is said to work well and to take a good polish. Its crushing strength, an average of three tests, is reported to be 21,104 pounds to the square inch.

The Penryn quarries also have been in operation since the early sixties. Bowlders as well as ledges have been quarried, and the stone has been used extensively in San Francisco. The granite is of gray (mottled white and black) color, and of coarse-grained appearance, with a slightly developed gneissoid structure. The light-colored minerals, which make up two-thirds of the rock, include both kinds of feldspar and a little quartz. The feldspars are translucent, colorless to pale flesh-colored, and free from alteration. The black minerals, which comprise the remaining third of the rock, are chiefly hornblende and biotite, intimately intergrown, and of brilliant black color. The apparent coarse grain of the rock is due to the tendency of the black minerals to segregate into small, nearly pure groups, which gives the rock an appearance very distinct from that of the majority of California granites.

Besides the granite just described there is, 1 mile east of Penryn, a "black granite," near gabbro in mineral composition, which has been quarried for monumental stone.

At Loomis, 3 miles south of Penryn, a biotite granite, intermediate in color and texture between the stones at Rocklin and Penryn, is quarried. It was used in the extension of the Hibernia Bank Building, San Francisco.

In Riverside County granite has been quarried on a large scale at Casa Blanca for rubble, used in the San Pedro breakwater, and for building and ornamental use at Corona, Riverside, and Temecula. At Corona both bowlders and ledges of a biotite muscovite granite

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are quarried, the former especially for paving blocks, a large number of which are made. In addition to building stone, a considerable quantity has given general satisfaction as monumental stone in Los Angeles, Riverside, and elsewhere in southern California.

At Temecula the granite is largely quarried from bowlders, since these are more easily worked than the ledges, which are for the most part covered with bowlders and residual soil. Paving blocks and dimension stone are produced. The rock is a biotite granite of light-gray color with a pale-reddish tint.

The quarries at Riverside and West Riverside have yielded a large quantity of granite for buildings in Los Angeles and vicinity. Two varieties have been noted by the writer: One a light-gray, medium-grained biotite muscovite granite, somewhat resembling the well-known Concord, N. H., stone; the other a medium-gray, medium-grained rather gneissoid biotite granite, in which the biotite tends to segregate into spots or bunches a quarter of an inch in diameter. In both varieties, the minerals are free from conspicuous alteration.

At the Casa Blanca quarries, the granite quarried for rubble contains a large number of dark blotches, but stone of uniform color is said to be available for building. Other quarries in Riverside County have yielded large quantities of stone for paving, road ballast, and concrete.

In San Diego County, Foster and Santee are the principal quarry centers, though granite for local use is quarried at a number of places. The granite from Foster has been used in the Government buildings at Fort Rosecrans on Point Loma, west of San Diego. Two varieties of granite are quarried at Foster. One is a medium gray fine-grained biotite granite, resembling rather closely the well-known gray granite from Westerly, R. I. The soda-lime feldspar is the most conspicuous of the light-colored minerals, owing to its white color, whereas the quartz and potash-feldspar are colorless. The soda-lime feldspar is somewhat altered, and some of its crystals have a greenish tint due to the presence of secondary epidote. A few of its crystals have been softened by weathering, but such crystals are too small to have any noticeable effect on the appearance and durability of the stone. The other variety is a light-gray medium to rather coarse grained gneissoid biotite granite of the same composition as the fine-grained variety; all its minerals are free from megascopic alteration. Associated with the gneissoid granite is a nearly white variety (aplite) containing only a very small quantity of biotite. It is not known whether this variety can be obtained in commercial quantities.

The granite from Santee is used largely for monumental work, also for building stone, and large quantities of it have been shipped to Los Angeles and other points in southern California. In monuments it resembles the widely used granite from Barre, Vt. The rock is of medium to rather dark gray color, distinctly darker than the average California granite, and of medium, even grain. It is composed essentially of bluish gray translucent feldspars and black intergrowths of hornblende, augite, biotite, and magnetite. All the minerals appear to be quite free from alteration. The rock takes a good polish, which, with its dark color, especially adapts it for monumental work.

At Dehesa, in San Diego County, there is an orbicular "black granite" or gabbro, that is well adapted for ornamental work, and would probably be unique among building and ornamental stones.

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The rock is characterized by abundant rounded segregations of varying textures uniformly scattered through a medium to rather coarse-grained matrix, and several varieties, based on variations in texture, are said to be available. The orbicular rock has been found only as residual bowlders. Other orbicular "black granites" have been found at Rattlesnake Bar, Eldorado County, and in Sierra and Plumas counties, but none has been quarried.

In Butte County a large amount of granite is available, but lack of transportation facilities has prevented development. In Fresno County at Academy, a dark, medium-grained granite is quarried from bowlders. In Los Angeles County granite has been quarried largely for crushed stone and in recent years for the Los Angeles aqueduct. In Nevada County granite somewhat marred by streaks and black "knots" for local use has been quarried from bowlders at Grass Valley, Nevada City, and Rough and Ready. Some fine-grained "black granite" suitable for monumental work has been reported from Rough and Ready. In Sacramento County a large granite quarry is operated by the State prison at Folsom, chiefly for construction work by the State. In San Bernardino County granite occurs over large areas and is quarried near Crucero, Declez, Halleck, Oro Grande, and Victorville. The chief products are paving blocks and rubble, but some building and monumental stone also is quarried. The county jail in San Bernardino was built of stone from a Victorville quarry. In Shasta, Siskiyou, and Trinity counties there are large quantities of granite, but it is said to be jointed, shattered, or streaked to such an extent that a great deal of it is not suited for quarrying. Gray granite has been quarried in Siskiyou County for monumental work 4 miles southwest of Etna and a nearly black rock (uralitic gabbro) 16 miles north of that place. In Sierra County there are extensive areas of granitic rocks that have not been prospected. In Tulare County granite bowlders have been quarried near Portersville, and a gray syenitic rock at Rocky Point. In Tuolumne County a fine-grained gray biotite granite has been quarried at the head of Phoenix Lake.

Dark volcanic rock (*"trap rock"*).—Published information on "trap rock," in distinction to other rocks of California, for use as crushed stone is very meager. Trap rock, or macadam, quarries represented on the accompanying map include not only diabase and basalt, the true trap rocks, but some other lavas, tuffs, granite, diorite, and possibly some sandstone, chert or jasper, limestone, shale, and gravel. In Solano and Sonoma counties the principal rock used is basalt; in Napa County, volcanic tuff. In Alameda, Marin, and San Francisco counties "blue rock" or metamorphic sandstone and chert or jasper are commercially termed trap rock, but in the present report certain of these quarries have been classed as sandstone. There is an abundance of basalt and diabase, as well as other suitable volcanic rocks in the State, though they are for the most part too far removed from the larger cities to be of value as crushed rock. In the vicinity of Santa Cruz basaltic rock is available, but it is said to be less suitable for road material than the chert layers which occur in the limestone formations.[1] The chert in this region is scarce. Red

[1] Branner, J. C., Newsom, J. F., and Arnold, Ralph, U. S. Geol. Survey Geol. Atlas, Santa Cruz folio (No. 163), 1909.

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chert or jasper ("red rock") well suited for road material occurs in good quantity in the vicinity of San Luis Obispo.[1]

Light-colored volcanic rocks.—Volcanic rocks, both effusive and intrusive, and mostly light colored, cover practically the entire area of the northeastern part of the State, and considerable bodies of them are distributed in the Sierra Nevada range and along the eastern border of the State as far south as the Mohave Desert. They are also found extensively in counties just north of San Francisco Bay, and smaller bodies are found in the region around San Luis Obispo. The rocks quarried are largely tuffs of different kinds, but in places include considerable amounts of lavas. The tuffs as a rule are soft and easily worked when quarried, but harden on exposure. They are also refractory, and have been extensively used, especially in the northern counties, for chimneys, fireplaces, and for fire bricks in stoves. The lavas, as a rule, lack the pronounced rift so characteristic of the granites, and break with curved fractures, but they are easily dressed, though not in large blocks, such as may be obtained in the granite quarries. The most important quarries of volcanic rocks are in Napa, San Luis Obispo, Siskiyou, and Sonoma counties.

In Napa County, at Calistoga, a yellowish trachyte and trachyte tuff are quarried, mostly from bowlders. The tuff was used in the St. Helena post office. Near St. Helena reddish and yellowish trachyte tuffs have been quarried and used in several buildings, including the public school, in St. Helena. Other quarries of gray and red trachyte tuffs have furnished stone largely for bridge and foundation work. The red tuff is suitable for trimmings in structures built mainly of the lighter-colored stone. In Sonoma County, which adjoins Napa County on the west and is covered by the same volcanic formations, the principal quarries are near Agua Caliente, Santa Rosa, Sonoma, and Stony Point. The stone quarried is mostly light colored, but a dark-red rhyolite tuff is quarried near Sonoma that has a considerable local use for trimming. Some of the tuffs are locally called sandstone, which they closely resemble in color and texture. In Santa Rosa the Carnegie Library and the California Northwestern Railway station are built of stone quarried east of the town; in Petaluma, the Phoenix Building, Carnegie Library, and other buildings are constructed of trachytic tuff from Stony Point. The prevailing products, however, of these stones are paving blocks, curbing, flagging, and railroad ballast.

In San Luis Obispo County there is a series of dacite and andesite buttes extending northwestward from near San Luis Obispo to Morro Rock, on the coast. The stone has been quarried largely for rubble used in breakwater construction, but has also been used in building construction. The Presbyterian Church and the Free Library in San Luis Obispo contain stone from Bishops Peak. The stone at Los Berros has been used for building in San Luis Obispo, Arroyo Grande, and to a small extent even as far away as Los Angeles.

In Siskiyou County a light-yellowish tuff, with narrow bands and patches of brown ("sap" stains) and white, has been quarried east of Montague and used in some of the buildings of Yreka. Quarries of a similar rock and of blue-gray to brick-red tuffs have been quarried near Little Shasta, and also used for building in Yreka.

[1] Fairbanks, H. W., U. S. Geol. Survey Geol. Atlas, San Luis Obispo folio (No. 101), 1904.

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Near Macdoel a pumice has been quarried and shipped to San Francisco as an ingredient for cement. There is some indication at present that pumice and other highly-porous rocks of low specific gravity may be in considerable demand as fillers in concrete mixtures where a minimum of dead weight is required, thus opening a much more extensive market than has heretofore existed for such types of stone.

The other counties in which volcanic rocks find a local use are given in the quarry list on page 1365. One of the most important formations not previously mentioned is that known as the Tuscan tuff, of Pliocene age, which occurs extensively in the region east of Redding, Shasta County. The extent and distribution of this formation are given by J. S. Diller in the Lassen Peak (No. 15) and Redding (No. 138) folios of the Geologic Atlas of the United States Geological Survey. According to Diller, this rock varies in texture from very coarsely fragmental to fine grained. The fine-grained variety is gray and usually distinctly stratified, and is composed of small fragments of andesite, in part pumiceous, with broken crystals of soda-lime feldspar and hornblende embedded in a fine gray matrix composed of minute angular particles of volcanic glass, which constitute the major part of the rock. Regarding its economic value, Diller says:

> The Tuscan tuff stands fire well, and being soft is easily hewn into shape. It is commonly used for chimneys and fireplaces, and in the vicinity of Millville a small church and several smokehouses are made of it. The Tuscan tuff is similar to the trass of the Rhine Valley, which is so extensively used in the manufacture of puzzolan cement, and there appears no good reason why it might not be used in the Redding region for the same purpose, especially since the necessary lime for admixture is abundant.[1]

Slate.[2]—California is the only one of the Pacific States that has produced slate. The slate quarried has all come from the Mariposa slate. The only important production has been in Eldorado County, but small quarries and prospects have been opened in Amador, Glenn, Mariposa, and Merced counties. Black slate has been the principal product, but a limited deposit of grayish-green slate has also been worked.

The black slate in the principal quarry, at Slatington, has a black or blue-black color, splits very finely and regularly with a smooth glistening surface, and resembles the slates of Bangor and Slatington, Pa. "Ribbons," or thin highly siliceous bands, are of frequent occurrence, and in some places pyrite is an objectionable impurity. Where quarries and prospects have proved unsuccessful, the rock exploited in some cases was weathered surface rock of poor quality, which may have capped slate of good quality; in others the slate was cut by numerous veins; in others the slate, after exposure for a few years, changed color owing to oxidation either of pyrite or some other iron compound, possibly a carbonate.

The green slate, an unusual alteration product of an igneous rock, forms a band (dike) several feet wide crossing the black slate obliquely to its ribbon structure in the principal Slatington quarry. It works satisfactorily as a roofing slate, though its cleavage surfaces are not as smooth as those of the black slate. It has been used for trimming and lettering on black slate roofs.[3]

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[1] U. S. Geol. Survey Geol. Atlas, Redding folio (No. 138), p. 14, 1906.

[2] More complete accounts of the slates of California, by E. C. Eckel, may be found in U. S. Geol. Survey Bull. 275, Slate deposits and slate industry of the United States, pp. 56–58, 1906; Bull. 586, pp. 65–70. 1914.

[3] A special description of the green slate by E. C. Eckel may be found in the Jour. Geology, vol. 12, pp. 15–29, 1904.

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Marble.—The marbles of California have mostly been quarried from crystalline dolomite and limestone strata of Paleozoic age, although the limestones of Triassic, Jurassic, and early Tertiary ages afford in places more or less suitable materials. The outlines of certain limestone and marble deposits of the State have been shown in a recent Survey bulletin.[1] Limited quantities of "onyx marble" and "verde antique" or serpentine marble, have also been produced. Marble deposits of greater or less extent have been reported from at least 28 counties, but many of them are too inaccessible to be of any present importance. Others are too thoroughly fractured or of insufficient attractiveness to give promise of successful development. Many of the "onyx marble" deposits are of too limited extent to be profitably worked.

One of the most interesting deposits reported, not only in California but in all the Pacific States, is that exposed along the southwest base of the White Mountain and Inyo Range, between Keeler and Lone Pine, in Inyo County. It has been quarried on a commercial scale only at Inyo. The marble is a dolomite, generally fine grained and rather hard. Several varieties are available: Pure white; white mottled with yellow, gray, and black and penetrated by black dendritic markings of manganese oxide; yellow, similar to the Siena marble of Italy, but more distinctly granular and more closely resembling the Estromoz or so-called Lisbon yellow marble of Portugal; black, suitable for floor tilings. These marbles are distinctly harder than many eastern marbles and the foreign marbles which they resemble.[2]

Another deposit containing a variety of colored marbles is worked at Columbia, Tuolumne County, and produces fine-grained marbles of pale pinkish, yellowish, and very light to medium gray colors, and coarser-grained marbles of medium to dark gray color. The degree of darkness increases with the percentage of graphite, which occurs in thin seams, irregular streaks, and patches.

At Neenach, close to the boundary between Los Angeles and Kern counties, a white marble with reddish-brown and heavy blue veins is quarried. At Colton, in San Bernardino County, a bluish-gray marble has been quarried for ornamental building and monumental purposes. Both of these marbles are represented in several buildings of San Francisco and Los Angeles. A nearly black variegated marble, rather distinct from most American marbles, is reported near Cadiz, and a brecciated marble of mottled green, black, and white appearance but rather excessively fractured is being worked near Barstow.[3] A deposit of fine-grained hard marble, mostly of gray or black and white colors but with strata of pink, yellowish, and reddish shades, has been prospected on the east edge of the Coyote Mountains in San Diego County. In the western part of Siskiyou County there is an extensive belt of white and gray marble. A pure-white coarse-grained variety is said to be especially abundant, though finer-grained marble is also present. A great variety of colored marbles have been reported from this belt but no further information on them is available. Informa-

[1] Eckel, E. C., Portland cement materials and industry in the United States, with contributions by E. F. Burchard and others: U. S. Geol. Survey Bull. 522, pl. 4, 1913.

[2] This paragraph is abstracted from G. P. Merrill's Stones for building and decoration, pp. 206–207, 1903. A brief account of the geology of the deposit is given by R. T. Hill in the Min. and Sci. Press, p. 86, July 20, 1912.

[3] Pack, R. W., Ornamental marble near Barstow, Cal.: U. S. Geol. Survey Bull. 540, pp. 363–368, 1913.

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tion is also scarce on other dolomite and calcite marbles from various counties not mentioned above. Some idea of their general locations and extents may be gained from the accompanying map.[1]

The most important deposit of "onyx marble" is at Musick in San Luis Obispo County. The deposit is composed of aragonite (the orthorhombic form of calcium carbonate) and forms layers 1 to 10 and in one place 30 inches in thickness. It is a translucent stone partly banded and variegated, partly white and massive, and takes a brilliant polish. Blocks from 3 to 6 feet square have been quarried, and larger ones are said to be obtainable.[2] At Cement, near Suisin City, in Solano County, a resinous travertine, through which are scattered veinlike and pocket-like deposits of a dark brown banded material, has been worked intermittently and used for decorative purposes in San Francisco. According to Merrill,[3] some beautiful material was obtained here, but slabs of any considerable size could not be found free from porous layers or much unattractive coloring. A small deposit of attractive deep brown "onyx marble" has been worked on Sulphur Creek, Colusa County. It formed a vein consisting of two seams, each about 5 inches thick. Small deposits of light brown veined "onyx" are found and occasionally worked in the marble quarries at Colton, San Bernardino County. Many other deposits have been found in the State, but most, if not all, are too small to be of any commercial importance.

Serpentine is widely distributed in California but most of it lacks the necessary qualities in structure and appearance to find favor as a marble. Only one quarry of any consequence has been worked—the "verde antique" marble quarry situated about 16 or 17 miles east of Victorville, in San Bernardino County. The stone is an irregular mixture of yellowish to dark-green serpentine and rather coarse-grained calcite. In places practically pure serpentine is said to be 5 to 10 feet thick; in others, white and bluish gray limestone with no serpentine is 10 to 20 feet thick. The handsomest stone is said to be that in which the bright yellowish green serpentine is banded with the dark green and with white limestone.[4] It has been used for interior decorations in San Francisco and Los Angeles.

At Empire Landing, on Santa Catalina Island, a very dark green serpentine is reported as forming bunches in association with soapstone. The one specimen from this locality seen by the writer is dark greenish rock, nearly black on polished surface, spangled with gray to green, more or less altered, tremolite crystals. It appears from megascopic inspection, to consist essentially of talc, chlorite, and serpentine, the latter occurring both in the groundmass and with talc, as partial to complete pseudomorphs after tremolite. Fine, scattered grains of pyrite are also present.

It may be appropriate to mention here a deposit of olive to grass-green vesuvianite (californite) rock, suitable for ornamental work, which has been prospected on the South Fork of Indian Creek, in Siskiyou County. The rock is said to occur as bowlder-like masses

[1] More definite data may be found in Bulletin 38 of the California State Mining Bureau, pp. 95–114, 1906, and on Eckel's map cited on page 1360.

[2] For detailed descriptions of this and other onyx marbles here mentioned the reader is referred to California State Mining Bur. Bull. 38, pp. 111–114, and to G. P. Merrill's Stones for Building and Decoration, pp. 268–271, ed. 1903.

[3] Op. cit., p. 269.

[4] California State Mining Bur. Bull. 38, pp. 147–148, 1906.

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in serpentine, and as loose bowlders in the creek bed. A full description of this unique stone has been given by Kunz.[1]

Soapstone.—Talc and soapstone are also widely distributed in the State, but are not extensively worked. Soapstone for local uses, largely firebacks, has been quarried in Butte, Los Angeles (Santa Catalina Island), Sierra, Siskiyou, Trinity, and Yuba counties, but no production was reported in 1912 and 1913. The production of talc and soapstone is considered by J. S. Diller in another chapter of the Mineral Resources of the United States.

Limestone.—Limestone and dolomite, mostly crystalline, are widely distributed in California and are quarried at different places for use as local building stone, for lime burning, sugar refining, cement manufacture, and other uses. Much stone of suitable composition is too far removed from important lines of transportation to be of more than local importance. The following paragraphs are intended to give the locations and, where possible, the characters of the most extensive deposits.

The most abundant supply in the State according to Diller[2] is in the Redding district, Shasta County. Here a thick belt of limestone of Triassic age, generally pure, is exposed east of Furnaceville, and forms Brock Mountain and may be traced for many miles to the north. A belt of more prominent limestone ridges and peaks, of Carboniferous age, extends northward from Lilienthal along the McCloud for many miles. Where best developed it is over 1,000 feet thick. A third belt of limestone of Devonian age is exposed near Kennett. Though not so extensive as the others, it is more accessible. The first two limestones have been quarried for flux, and the last is extensively quarried and burned for lime at Kennett. Limestone of Paleozoic age also occurs extensively in Siskiyou and Trinity counties, but none is quarried in the latter county.

The limestone lenses in the Calaveras formation (Carboniferous) afford an abundance of limestone, and have been quarried in Amador, Eldorado, Placer, and Sierra counties, as indicated on the quarry map. In Kern County, a broad belt of coarsely crystallized blue and white limestones, generally much shattered, extends along the north border of Tehachapi Valley and supplies material for the important lime industry at Tehachapi. Crystalline limestone, mostly coarse grained and as a rule almost pure calcium carbonate, is also quarried in Monterey, Riverside, San Bernardino, and Santa Cruz counties. In the last-named county large persistent beds of shattered blue and white limestone are entensively quarried northwest of the city of Santa Cruz and at Felton.

In Santa Clara County, on Black Mountain, a thin-bedded, shattered limestone, colored dark gray to nearly black, has been quarried; 2 miles southeast of Los Gatos a fine-grained, thin-bedded cherty limestone has been worked. In Santa Barbara County a soft, fossiliferous Triassic limestone, chalky in places, and much shattered, has been worked 6 miles southwest of Lompoc for use in sugar refining.

[1] Kunz, G. F., Californite (vesuvianite), a new ornamental stone: Am. Jour. Sci., 4th ser., vol. 16, pp. 397-398, 1902.

[2] Diller, J. S., Limestone of the Redding district, California, U. S. Geol. Survey Bull. 213, p. 365, 1903. See also U. S. Geol. Survey Bull. 225, pp. 176-177, 1904; and U. S. Geol. Survey Geol. Atlas, Redding folio (No. 138), 1906.

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In San Joaquin and Contra Costa counties travertine or aragonite has been quarried for lime. The deposit in the former county was worked three-quarters of a mile south of Carnegie, and comprises a series of veins varying from 3 inches to 3 feet in thickness.

In addition to the quarries indicated on the map the following deposits are known to be available:[1] In Kern County, 18 miles east of Cantil, and 15 miles west and south of Mohave; in Monterey County, 26 miles south of Monterey; in Riverside County, half a mile to a mile south of Whitewater (suitable for beet-sugar refining and cement manufacture), 14 miles southwest of Mecca, and 5 miles northwest of San Jacinto; in San Benito County, in the mountains south and east of San Juan and 9 miles south of Hollister (suitable for lime and cement manufacture); in San Bernardino County, near Hinkley and 9 miles southeast of Kelso (both suitable for lime and cement manufacture); and in Tulare County, 9 miles east and a little south of Portersville station (suitable for lime and cement manufacture).

Sandstone.—Sandstones suitable for building are mostly limited to the Cretaceous and Tertiary formations, which cover extensive areas in the Coast Range and border the northern and central parts of the Sierra Nevada. The prevailing colors are yellow to buff, bluish or greenish gray, and brown. Many of the sandstones, like the volcanic tuffs, are soft when quarried but harden on exposure.

The sandstones which have attracted most attention are quarried in Colusa, Los Angeles, San Luis Obispo, Santa Clara, and Ventura counties. That from Colusa County is quarried near Sites. It occurs in massive beds of bluish or greenish gray to buff color, and is composed chiefly of quartz and feldspar grains in a greenish argillaceous and somewhat calcareous matrix. Tests of the Colusa Sandstone Co.'s stone gave the following results: Specific gravity, 2.56; water absorbed in 24 hours, 3.03 per cent; crushing strength, 8,440 to 8,940 pounds per square inch. Its behavior when subjected to fire and to other sudden temperature changes was generally satisfactory.

In Los Angeles County the principal sandstone quarries are at Chatsworth Park, near Chatsworth station. The stone is fine grained and rather heavily bedded, tawny yellow near the surface, but bluish gray at greater depth where it is unaffected by oxidation. It consists of grains chiefly of quartz and feldspar with some of black and white micas in an argillaceous matrix. It has been used in San Bernardino, Santa Ana, and Los Angeles.

Sandstone in Santa Clara County has been quarried at Graystone and elsewhere. The Graystone quarries furnish a yellowish to buff, medium to fine-grained stone, composed of quartz, feldspar, and a few mica grains in an argillaceous and calcareous cement. Tests have yielded the following results: Weight per cubic foot, 165 pounds; absorption of water, 5.13 per cent; crushing strength (of a single specimen), 2,400 pounds per square inch. Its resistance to fire and to other severe temperature changes was generally good. The buildings of Leland Stanford Junior University, at Palo Alto, are built of this stone. The Carnegie Library of Santa Cruz is constructed of sandstone quarried near Los Gatos, Santa Clara County.

In Ventura County brown sandstone has been quarried, mostly from large bowlders, in Sespe Canyon, 5 or 6 miles from Brownstone

[1] Information furnished by J. A. Taff, geologist Southern Pacific Co., San Francisco, Cal.

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station. The stone is rather fine grained, and consists chiefly of white quartz and feldspar grains in a brown matrix, which contains considerable calcium carbonate. Tests have resulted as follows: Specific gravity, 2.65; weight per cubic foot, 165.6 pounds; absorption of water, 1.53 per cent; crushing strength, 4,122 pounds per square inch (load applied normal to bedding) and 3,892 pounds per square inch (load applied parallel to bedding). The stone has been found of considerable use in San Francisco, Los Angeles, and Pasadena.

In San Luis Obispo County Cretaceous and Tertiary sandstones have both been quarried, but no explicit information concerning them has been obtained. Other sandstones of interest are the very fine-grained red and pure white argillaceous sandstones near Ione, Amador County; light blue and buff fine-grained sandstone in Contra Costa County; green, blue, red, dark yellowish, and drab sandstones quarried 6 miles south of Tehachapi and used in Los Angeles and Pasadena; bluish or greenish gray, fine-grained, argillaceous sandstone quarried on Angel Island, Marin County, and used in San Francisco; light buff, rather coarse-grained sandstone of Miocene age, quarried in the Santa Ynez Mountains near Santa Barbara and used in Santa Barbara and Los Angeles; tawny colored sandstone of the Chico formation (Upper Cretaceous), quarried near Redding, Shasta County, and used considerably in northern California; and the tawny and gray sandstones, the latter closely resembling the sandstone quarried near Henley and Yreka, in Siskiyou County.

Production.—The total production of stone in California in 1913 was valued at the quarries at $4,118,935, compared with $3,902,313 in 1912.

Directory.—The quarries of all kinds of rock quarried in California are listed below by class of rock, county, and town (or post office):

Directory of stone quarries in California.

GRANITE.

Amador County: 1. Jackson.
Calaveras County: 2. Milton (Gopher Ridge) (porphyrite).
Fresno County: 3. Academy (Clovis) (2).
Humboldt County:
4. Arcata (3).
5. Eureka.
Lassen County: 5a. Susanville.
Los Angeles County: 6. Azusa.
7. Hollywood (Independent station, Los Angeles).
8. Monrovia
9. Pacoima or San Fernando (2).
Madera County: 10. Raymond (3).
Mariposa County: 11. Jasper Point.
Napa County: 12. Napa (2).
Nevada County:
13. Grass Valley.
14. Nevada City.
15. Rough and Ready.
Placer County:
16. Lincoln.
17. Penryn (2) and Loomis.
18. Rocklin (24).
Plumas County: 19. Chilcoot and Cuba (3).
Riverside County: 20. Corona (6).
21. Elsinore (4).
22. Perris (2).
23. Riverside (8) and West Riverside.
24. Temecula Station (5).
Sacramento County: 25. Represa (Folsom).
San Benito County: 26. Logan.
San Bernardino County:
27. Crucero.
28. Declez (3).
29. Halleck (2).
30. Hesperia.
31. Victorville (4).
San Diego County:
32. Campo.
33. Dehesa.
34. Escondido.
35. Foster (2).
36. San Diego and Helix (3).
37. Santee.
San Luis Obispo County: 38. Port San Luis (Port Hartford)
Santa Clara County: 39. San Jose.
Sonoma County: 40. Santa Rosa (3).
Tulare County: 41. Portersville (3).

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DARK VOLCANIC ROCK (BASALT, ETC.)

Alameda County: 1. Berkeley.
Butte County: 5. Oroville.
Contra Costa County: 6. Richmond (4) (includes 1 at Point Richmond).
Fresno County: 7. Reedley.
Humboldt County: 8. Eureka.
Kern County: 9. Caliente.
Los Angeles County:
10. Acton (2).
11. Redondo Beach.
12. South Pasadena.
13. Spadra.
Marin County: 14. San Rafael (2).
Napa County: 16. Napa (3).
Sacramento County:
17. Dredge (mail Mills).
18. Folsom City (State Prison Quarry).
19. Natoma.
San Luis Obispo County: 21. Santa Margarita.
San Mateo County:
22. Belmont.
23. San Mateo (2).
Siskiyou County: 25. Dietz.
Solano County:
26. Benicia.
27. Cordelia.
28. Vacaville.
Sonoma County:
29. Anadel and Kenwood (2).
30. Melitta (3).
31. Petaluma (4) and Pengrove.
32. Santa Rosa (2).
33. Sonoma (5).

LIGHT-COLORED VOLCANIC ROCKS.

Alameda County: 1a. San Leandro.
Butte County: 1. Pentz (Curtis ranch).
Calaveras County:
2. Jackson (Mokelumne Hill).
3. Vallicita.
4. Valley Springs.
Eldorado County: 5. Smith Flat (near Placerville).
Inyo County: 6. Laws (6 miles west of.)
Los Angeles County: 7. Avalon (between Avalon and Empire Landing).
Merced County: 7a. Merced Falls.
Napa County:
8. Calistoga (5).
9. Napa (4).
10. St. Helena (4).
San Luis Obispo County:
11. Arroyo Grande.
12. Bishops Peak (Cerro Obispo) (2).
San Luis Obispo County—Continued.
13. Los Berros.
14. Morro Rock.
Siskiyou County:
15. Little Shasta (2).
16. Macdoel.
17. Montague (8 miles east of).
Solano County: 18. Winters (southwest of).
Sonoma County:
19. Agua Caliente.
20. Santa Rosa (2).
21. Sonoma (3).
22. Stony Point (2).
Sutter County: 23. Sutter City (Marysville Buttes).
Tehama County:
24. Paskenta (north of).
25. Red Bluff (20 miles west of).

SLATE.

Eldorado County:
1. Placerville (2).
2. Slatington.
Mariposa County: 3. Hornitos.
Merced County: 4. Planada (11 miles east of).

MARBLE.

Amador County:
1. Plymouth (2).
2. Sutter Creek.
Butte County:
3. Pentz.
4. Oroville.
5. Pulga.
Calaveras County:
6. San Andreas (3).
7. Vallicita.
Inyo County:
8. Inyo.
9. Swansea.
Los Angeles County:
10. Avalon.
11. Neenack (includes adjacent deposit in Kern County).
Mono County: 12. Topaz.
Riverside County:
12a. Eolom station (6 miles south of).
12b. Eolom station (7 miles southwest of).
San Bernardino County:
13. Baker.
14. Barstow.
15. Mentone.
16. Victorville (2).
San Luis Obispo County: 17. Musick (Arroyo Grande).
Siskiyou County: 18. Indian Creek.
Tuolumne County:
19. Columbia (2).
20. Sonora.

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LIMESTONE.

Calaveras County:
1. Campo Seco (3).
2. Fosteria (4).
3. Murphy.
Modoc County: 4. Cedarville.
Monterey County: 4a. Salinas (6 miles southeast of).
Nevada County: 5. Grass Valley
Riverside County:
6. Corona (Orange).
7. Riverside.
Riverside County—Continued.
8. San Jacinto.
San Bernardino County:
9. Cajon.
10. Colton.
San Mateo County: 11. Rockaway.
Santa Clara County: 12. Mountain View.
Shasta County: 13. Ingot.
Tulare County: 13a. Lemon Cove (2 miles northeast of).

LIMESTONE AND LIMEKILNS.

Alameda County:
1. Berkeley.
2. Pleasanton.
Amador County: 3. Ione.
Contra Costa County:
4. Concord.
5. Cowell (mail Clayton).
Eldorado County:
6. Cool and Auburn.
6a. Cothrin (2 miles north of).
Kern County: 7. Tehachapi (5).
Los Angeles County: 8. Los Angeles (2).
Mono County: 9. Mono Lake.
Monterey County: 10. Monterey.
Orange County: 10a. Capistrano.
Placer County.
11. Colfax.
12. Newcastle.
San Benito County:
13. Hollister (3).
14. San Juan.
San Bernardino County:
15. Oro Grande (Halleck post office) (3).
16. Victorville.
San Luis Obispo County: 17. Adelaide.
Santa Barbara County: 18. Lompoc (2).
Santa Clara County: 19. Los Gatos.
Santa Cruz County:
20. Davenport.
21. Felton and Rincon (2).
22. Santa Cruz (4).
Shasta County:
23. Kennett (5).
24. Redding (2).
Siskiyou County:
25. Callahan.
26. Fort Jones.
27. Gazelle (2).
28. Greenview.
Solano County: 29. Cement.
Sonoma County: 30. Geyserville.
Tuolumne County:
31. Jacksonville.
32. Sonora (2).
Ventura County:
33. Oxnard.
34. Ventura

SANDSTONE.

Alameda County:
1a. Oakland (8).
1b. Piedmont.
Amador County:
1. Ione.
2. Lancha Plana.
Calaveras County: 3. Valley Springs.
Colusa County: 4. Sites (2).
Contra Costa County:
5. Clayton.
6. Martinez (2).
7. Stege (2).
Del Norte County: 8. Crescent City.
Kern County: 9. Tehachapi (6 miles south of).
Los Angeles County: 10. Chatsworth (3).
Napa County:
11. Napa (2)
12. St. Helena.
Orange County:
13. El Modeno.
14. Santa Ana (2).
San Francisco County: 14a. San Francisco (5).
San Luis Obispo County:
15. Berros.
16. Edna (near).
17. Santa Margarita (near).
San Mateo County:
18. Colma.
18a. San Pedro Point.
Santa Barbara County:
19. Montecito.
20. Santa Barbara (14).
Santa Clara County:
21. Graystone.
22. Los Gatos (10 miles from).
Shasta County:
23. Redding (northeast of) (2).
24. Texas Spring.
Siskiyou County:
25. Henley (2).
26. Yreka (2).
Sonoma County:
27. Coast Bluffs.
28. Freestone (2).
29. Petaluma (2).
Stanislaus County: 30. Knights Fery (Wright ranch).
Ventura County:
31. Camarillo.
32. Santa Susana.
33. Seepe.
Yolo County: 34. Winters (2).

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NEVADA.

By E. F. Burchard.

The larger part of the area of Nevada is occupied by Tertiary effusive rocks, consisting of rhyolite, andesite, and related types, and tuffaceous rocks. There are in the extreme western part of the State in the Sierra Nevada, and at a few places in the interior, small areas of post-Cambrian intrusives which include granite and diorite. There are also, on the flanks of the mountain ranges, most of which have a general north-south trend, areas of sedimentary rocks of Ordovician, Devonian, Carboniferous, Triassic, and Jurassic age, including limestone, sandstone, and shale, in part metamorphosed. In the basins between the mountains are Tertiary sediments and wash of Quaternary age. The State is therefore bountifully supplied with stone of all kinds, but it is not likely that important quarrying industries will be built up except in the vicinity of the larger towns. The writer has had no opportunity to make field investigations of the stone resources of Nevada. Prof. J. C. Jones of the Mackay School of Mines, University of Nevada, has kindly furnished notes on the general features of the quarry industry and has made certain additions and corrections on the quarry map, and the writer herewith expresses his appreciation for this courteous assistance.

According to Prof. Jones nearly every town of any size in Nevada has its local "quarry" where stone is obtained from time to time for foundations and other rough work, as it is customary for builders to go out into the hills and get stone when any is needed rather than to maintain a regular and continuous quarry. Considerable stone has been obtained from a quarry in hornblende andesite about a mile north of Reno, and the stone for the water table of the new library building of the University of Nevada at Reno was obtained from a quarry in rhyolitic tuff about 2 miles southwest of the town. Several other small quarries in similar stone are reported to have been opened in that vicinity. The quarries near Merrimac and Tonopah are also in rhyolitic tuff. At Reno granite is obtained from bowlders that have been washed down from the Sierra by Truckee River. Stonecutters report that these bowlders yield fresher and sounder rock than can be obtained from rock in situ. Of the marble quarries the one at Carrara is the only one in active operation at present (Jan. 30, 1914), though the quarry at Mina is to resume operation soon. There is no question as to the quality of the marble in the Nevada quarries. The retardation in their development has been due in most instances to lack of capital to push their product. There is an abundance of suitable stone in Nevada, but the small demand and consequent scarcity of stonecutters make it cheaper to import stone, unless there happens to be a large building or contract that makes it possible to bring in the necessary skilled labor. Practically all the stone used in trimming is imported from other States, much of it coming from Bedford, Ind. Such granite as is used comes from across the Sierra, chiefly from Rocklin, Cal.

The following notes are abstracted from a bulletin of the Department of Geology and Mining, University of Nevada, entitled "Preliminary report on the building stones of Nevada," by John A. Reid, published in 1904. Prof. Reid's notes fortunately deal with the undeveloped stone resources as well as with those that are quarried.

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Granite.—The east flank of the Sierra and the area along the foothills is characterized by an abundance of crystalline rocks, all more or less connected in origin yet varying from those termed granite to those of dioritic nature. The term granite is, however, used here for such rocks as might commercially be included in this class.

Granite occurs in the immediate vicinity of Laughtons station, to the north of the Southern Pacific Railroad track, about 5 miles west of Reno. Considerable rough stone has been taken out at the outcrop directly on the railroad, but no real quarry face has been opened. In color this granite is a medium to light gray, with occasional splotches of a darker shade. The rock is susceptible of a good polish, quite in contrast to the rough finish. Considerable joint structure is developed on a large scale, sufficient to make quarrying easy, and yet not enough to preclude the possibility of extracting large blocks. The texture is of medium fineness in the main phase of the stone, but varies considerably. The normal rock has much more white mineral than dark, but often rounded spots occur which contain a much larger percentage of black constituents. Little or no pyrite is present. The stone, because of its location on the railroad, is available at once and in large quantity. It can be used for ornamental work if no variations in texture are present, and for all the more common structures, such as foundations, curbing, walks, and the like, it will give satisfaction.

In the vicinity of the town of Verdi, about 10 miles west of Reno on the Southern Pacific Railroad, considerable areas of granite exist. Much of it is directly on the railroad, south of the town, along Truckee River. There are two types of granite here. The first type is that which makes up most of the mass. The color is a rich dark gray, with a faint trace of pink, giving as a result a very handsome stone. It is susceptible of a high polish, showing quite dark in comparison with the rough surface. As to the structure of the rock, some faulting has occurred, and joint planes are probably developed. From the outcrops existing, the texture appears fairly constant, there being a slight change in color in widely separated localities. The sulphides are in very small quantity. The stone seems to be remarkably free from imperfections in this respect. Like the Laughton stone, it is so situated that it is available at any time with lowest possible cost of handling. For monumental work, as well as for all the best uses, this granite should find a ready market. The second variety of granite from Verdi is found at present only in bowlders lying on the worn surface of the other granite. It undoubtedly occurs as veins in the main mass, and should properly be called a pegmatite. The color is either a light red ground through which are irregularly dispersed black shining crystals of tourmaline, or more rarely, a white ground with the dark mineral. The general effect is very pleasing to the eye. The quartz and feldspar are of fine grain, while the black mineral, in coarser crystals, is in spots in size from a quarter of an inch up to a foot or more. The stone will take a high polish, differing little from the unfinished surface in shade. It should meet with favor for some kinds of ornamental work, as well as for building material, if it can be obtained in large enough quantity.

Granite outcrops west of the old town of Washoe, on the Virginia & Truckee Railway, and is a part of the great granite mass occurring at the east base of the Sierra. A quarry is opened about a mile west

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of the town, and the stone has been shown to be of fairly uniform color and grain. The color is a medium dark gray, with a very faint pinkish tinge, lighter than the rock near Verdi. There appear to be few or no imperfections in structure debarring the extraction of large pieces for use, but, in common with most of these rocks, the texture varies somewhat. The sulphide minerals are rare, as in all of these rocks. A good polish is taken, quite dark compared with the unfinished stone. The granite is used for monuments and ornamental purposes.

Granite is well exposed at Ophir, about a mile northwest of Franktown, on the Virginia & Truckee Railway. A little preliminary quarrying has been done at a point just south of the wood flume, on the small creek here draining down from the mountains. The stone rises about 100 feet above the creek, giving opportunity for working. The color is the lightest of all those described, being, in the average, a very light gray. Some varieties, small in amount, are darker in shade. A good polish is possible, which is little darker than the rough surface. Jointing is well developed, insuring ease in quarry work while not preventing the extraction of large blocks. In texture the rock as a whole varies considerably, though the main mass is fairly constant. Normally the crystals of the compartment minerals are fine in grain.

Granite is well shown in the railroad cuts south of the station of Lakeview, 3 miles northwest of Carson. The color is a light gray, similar to but darker than the Ophir granite. In the exposed outcrop many little dots of red are to be seen on careful inspection. The mass of the rock is quite faulted and jointed, but blocks of large size can be taken out, judging by the weathered portion. The texture is rather coarse because of the large size of the hornblende crystals; the light colored constituents are of finer grain. Magnetite shows quite plentiful under the microscope. Such a rock as this is limited in usefulness to the commoner demands, and it is also possible, on account of the mineral content, to use it as a road metal. Its vast quantity, ease of access, small mica percentage, and comparatively large percentage of iron, make it possible that it might prove a success as a material for macadamized roads. On the Prison Hill at Carson, a similar granite outcrops from beneath the andesite flows. This locality is not on the line of the railroad, but is easily approached by teams.

Near the town of Luning, Esmeralda County, 5 miles from the railroad, is an occurrence of fine-grained white granite. No real quarrying has been done, and only a small quantity of stone has been extracted. Small pieces show a finer grain than the other granites described.

Granite occurs near Mason Valley, in Hudson Pass, Lyon County, about 18 miles from the railroad. As with most of the other rocks, little quarrying has been done. The color is rather striking, being a light mottled pink-gray. On close inspection three distinct colors are noticeable—white, pink, and dark green. The polished surface brings these out well, and presents a considerable and pleasing contrast with the rough finish. The grain is medium and even, with an occasional large white crystal. This stone can be used for ornamental work and buildings, and should find a ready market.

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Two varieties of granite are used in Winnemucca. The first is quarried 12 miles north of the town, and hauled in by teams. It is a medium light gray stone, taking a fine polish, and is sufficiently good for the best class of work. The grain is medium coarse, with little variation in color or mineral content. The second granite used in Winnemucca is taken from bowlders found on the lower slopes of Winnemucca Mountain. In color and general appearance it is much like the first, but takes a poorer polish. It also has found some demand for monuments and buildings, but is inferior to the first because of longer exposure in fragments. However, it is well adapted to all the commoner uses.

Much granite exists both north and south of the town of Elko but at some distance. At present one variety is quarried, about 30 miles north, and is used in the town for nearly all purposes.

The mass of Mount Davidson, upon whose eastern flanks Virginia City lies, is chiefly of a dioritic rock. This rock may not make a first-class building material, for its color is a somber gray, its grain fine, and the whole aspect is uninviting. It is mentioned because of its possible use as a road metal. Its constituents are feldspar and hornblende, with usually some iron pyrite. The texture is one of interlocking crystals, causing very great toughness.

Light volcanic rocks.—There are two stones used in Nevada which are classed with this group of rocks. Both are from the region just south of Virginia City, near the American Flat tunnel, on the line of the Virginia & Truckee Railway, in Lyon County. Both are quartz porphyrites in a general sense, though there are variations from a true quartz porphyry or rhyolite to a quartz andesite, or dacite, based on the nature of the included feldspars. Rhyolite is quarried from the great mass covering many acres, at a point on the railroad one-fourth of a mile west of the American Flat tunnel. The color is yellowish white, a suitable shade for a dry, dusty climate. The texture is porphyritic and even throughout larger masses. The general effect is good. Rather large glassy quartz grains give the rock a distinct individuality. The hardness is high, the toughness a little less, and both rank with the best. The rock shows much resistance to atmospheric changes, so that long life to a structure of this material is assured. This stone was much used in the early days on the Comstock, chiefly for foundations. It shows no evidence of change where so used. The railroad now constructs of it abutments, culverts, retaining walls, and other similar structures.

Another quartz porphyry is quarried five-eighths of a mile east of the tunnel already mentioned. The color in the mass is a medium-dark purplish. The texture is porphyritic, with well-developed crystals of quartz, feldspar, and dark mica. The color is due to the purplish gray groundmass, in which the other minerals show distinctly. The main difference between these two rocks is in the color and the increase in the proportion of mica in the purplish variety. This latter stone is decidedly pleasing to look upon and should find favor for buildings. Its hardness, toughness, and other characteristics are favorable, and it is quarried by the railroad and used in some of its culverts and abutments. It has been used in one of the railroad crossings at Steamboat Springs and makes a fine appearance.

There are several quite important building stones among the andesites, including some of great promise. As the demand for such mate-

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rials of construction increases, these stones should all find ready markets, particularly as they are easy of access and near the centers of population.

Andesite is the stone used largely in the erection of the new Carnegie Library building in Reno. It is locally called a sandstone. It comes from one of the Recent large andesite flows on the lower eastern flanks of the Sierra. The quarry is situated at a point about 4 miles southwest of Reno, though nearly 2 miles farther by road. The quarry shows well the flow structure of the mass; the planes of motion lie nearly horizontal, greatly facilitating the extraction of large blocks. The color is a medium light red or red gray, similar to but redder than the tint of the quartz porphyry at Virginia City. The texture is porphyritic, showing white feldspar crystals with smaller ones of mica and hornblende in the red gray groundmass. The white feldspar is all that shows on a cursory examination, and as much of this mineral is present the popular term sandstone has been employed. The hardness and toughness are low for a rock of this type and are little better than in an average sandstone, sufficient, perhaps, for all ordinary demands but not enough for the very largest buildings now erected. It will withstand much in the nature of temperature changes, as will all the rocks of this group.

On the western side of the ridge on which this quarry is situated is a second outcrop of similar rock, gray in color. The lasting qualities of the gray rock are much better. The two stones are in pleasing contrast and will undoubtedly find favor.

There are two varieties of andesite at Huffaker, 5 miles south of Reno. The railroad here skirts the foot of a rather low hill on which the rocks in question outcrop. They are both part of the same mass.

The first is a red stone, a shade darker than the library andesite. It forms most of the surface material and can be obtained in quite large quantity. It has no flow planes like the first-mentioned andesite. It is porphyritic in texture, showing well-formed crystals of black hornblende, red discolored lath-shaped crystals of feldspar, all in the red groundmass. The hardness is medium, the toughness somewhat less. The availability of the material is a strong point in its favor, as it outcrops less than 100 feet from the railroad track. The second variety is a granitic rock and popularly might be called a granite. It is a medium light gray stone, apparently showing quartz, feldspar, and hornblende. Careful study, with and without the microscope, shows it to be a truly porphyritic rock of medium grain and even texture. The general aspect of the rock is decidedly in its favor. The Huffaker residence, a large two-story structure, is made of this material, which shows no change in its 30 years of service.

Andesite exists north of Reno over considerable territory. A quarry in the best material is about 2 miles north of the University campus, just above the railroad. The color is a light greenish gray in the mass, a restful one in the glare of the sunlight in a hot, dry climate. The rock is rather strikingly porphyritic on close inspection, though of even appearance at a little distance. Large glassy feldspar crystals half an inch in length are abundant. Also many flakes of dark mica are present, with a little hornblende, all set in the compact, greenish-gray groundmass. In selected pieces the texture is fairly constant, but as a mass much variation occurs. Inclusions of other materials are found, and small cavities are plentiful, so that

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careless work may result in unsightly spots in buildings. The hardness and toughness are fair, and the resistance to weather changes is good. As it is on the railroad, it is easily available, and there is a vast quantity in sight. The stone has been used considerably in Reno. Several of the newer University buildings, the gymnasium and Lincoln Hall, contain it, and a few structures in the business part of town are made wholly, or nearly so, of the material. Another possible use is that of road metal.

About 2 miles east of the old town of Virginia City runs a ridge approximately north and south. Sugar Loaf peak is part of this ridge, which is cut in two by Sixmile Canyon and Creek. Two varieties of andesite are found in this ridge. The first of these is quarried at a point just east of the Brunswick Lode, on the east side of a small hill rising from the ridge. Considerable rock has been taken out here, yet no well-cut face is shown. The structure of the mass is columnar. The columns, averaging 2 feet or more in diameter, pitch to the northwest at a low angle, aiding quarrying. This stone is the most striking in appearance of all those described in these notes, and is very handsome. The texture is porphyritic, and large rounded feldspar crystals often half an inch across, with smaller prisms of hornblende and flakes of dark mica appear in a blue-gray or steel-blue groundmass. The feldspar is quite glassy, much in contrast to the lusterless colored ground. There is some variation in texture which must be guarded against by selecting only the best. Frequently small inclusions with slightly different color and grain occur, which spoil the even effect. The hardness, toughness, and other characteristics are good and need little consideration under ordinary circumstances. The stone is easily obtained, the quarry being less than 2 miles from the railroad. It was used extensively in the early days of the town for foundations for large machinery. The second variety of these andesites occurs in Sugar Loaf and in the exposed places in the immediate vicinity. It has not yet been quarried nor used. A fine exposure is present southwest of the road in Sixmile Canyon where the bridge spans the creek at the base of Sugar Loaf. This rock is very similar to the first, yet distinct in its general appearance. The groundmass is a very light gray, with a faint tinge of blue, and the well formed minerals are white feldspar, in smaller crystals than in the first phase, with black hornblende more plentiful than before, and a little dark mica. The other qualities are about the same as those of the first variety and are good.

There are three tuffs now in use in the State. They are softer than the average consolidated tuff, yet this lack does not prevent their being used in many important ways. They fill a want for certain kinds of materials better than any other stone and at times rank with the best sandstones. Tuff outcrops in the Virginia Range in the canyon of Carson River, at Merrimac station, within easy reach of all important points. The quarry is on the south bank of the river, and is one of the very few well-opened quarries in Nevada. The color of the stone is a light pink, almost a flesh color, and does not vary throughout the mass. As it is composed of volcanic ash, with some mineral fragments, its texture might be taken to indicate a very fine-grained sandstone. The fragmental character is clearly shown, and the absence of stratification planes or layers indicates to the unaided eye the nature of the material. The ash is largely

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glass, in minute fragments, in which are imbedded a few angular pieces of mica, quartz, and feldspar. The grain is very even for such a stone, and its general effect is very good. Its hardness and toughness are low, about equal to a soft sandstone and too low to warrant its use under much stress. It tempers a little on standing, but not sufficient to increase its strength greatly. It is rather porous, as are all the tuffs, yet withstands temperature changes well because of its internal structure. It has been used very largely in and about Carson and Reno chiefly for copings, cornices, lintels, arches, and for other purposes requiring little strength. When used with brick or with any other material harmonizing with it in color a very pleasing contrast is presented. The Gymnasium and Lincoln Hall of the University Buildings both contain it; some brick residences in Reno are much improved by its use; and the new Elk's Hall shows it to advantage.

Tuff occurs in a mass of consolidated ash almost 20 miles northeast of Reno, on the Spanish Springs Valley road. A little stone has been quarried and used in Reno in ways similar to the rock at Merrimac station. Its color is a light pink, a little lighter than the first material. These two stones are very similar in their features and can be used in precisely the same ways and for the same demands. This second tuff, however, is more irregular in texture, containing angular fragments of other rocks, largely andesite and granite, thereby appearing somewhat mottled when closely inspected. It tempers slightly better than the other. Careful selection should eliminate the unsightly stone from that quarried.

Tuff occurs in the hills northeast of the town of Lovelock, on the line of the Southern Pacific Railroad. Some has been obtained about 4 miles from the station. The color is a purplish gray, of a medium depth of tint. The structure and texture are in general the same as in the other tuffs. Many small fragments of volcanic rocks are interspersed throughout the mass, and small glassy crystals of feldspar are quite noticeable on careful inspection. The rock inclusions are dark gray, so that a close view exhibits many seeming imperfections in grain. Used in a building these are not apparent, and the whole aspect is a very pleasing one. The usual shade of purple will give a pretty contrast with other stones whose color blend with its own. The hardness and strength are good, ranking well up with that of the best sandstones, while at the same time it is resistant to atmospheric changes. A vast quantity is in sight here.

A volcanic agglomerate or a consolidated volcanic mud is found on the railroad at Washoe. Several of the old abandoned buildings of the once thriving town are made wholly of this stone, an unusual material for purposes of construction. The color is mottled light and medium dark gray and the surface usually appears dusty. The texture is quite porous. Nothing in the way of definite substances or minerals can be easily determined or distinguished. Its lasting qualities rank with an average sandstone, but its strength is less.

Marble.—The marbles are well represented in Nevada, although little has been done to develop them. Only a few are quarried, owing to the irregular demand and the difficulty of gaining a market against other stone now used.

On the borders of La Moille Valley, in Elko County, exists a vast quantity of a fairly good variety of marble. No quarrying has been

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done, but some stone has been taken out to show its character. The color is white in one variety, and a gray, or a laminated gray and white, in another. The white is clear, not marked by yellowish spots or flaws. The stone is rather finely crystalline, and takes a good polish. The marbles are all hard and brittle. The rock is not very far from transportation facilities and should meet with some demand. The uses are mainly interior ones, such as tiling for floors, mantles, and mosaic work. In the Humboldt Mountains a considerable quantity of coarsely crystalline marble exists, which may prove of some value upon more careful investigation. What rock has been seen shows a pure white color with few impurities appearing on weathering. Gray and white marble exist in the region in the vicinity of Luning, Mineral (formerly Esmeralda) County. Some of this has been quarried and used in Carson and it ranks with the others mentioned. It outcrops on the railroad; hence is easy of access.

In addition to the marbles mentioned by Reid, marble has been discovered about 14 miles north of Las Vegas, and near the Las Vegas & Tonopah Railroad, about halfway between Las Vegas and Tonopah. Here the town of Carrara has been established and quarries have been opened. Several varieties of marble are found here. The grain is generally very fine and uniform, and the stone is susceptible of a high polish. One sample sent to the University of Nevada is of an olive-green shade. Prof. Jones considers that the color may be due in part to serpentine and in part to organic matter. The variety "Pavonazzo" is of a light cream color, with a few irregular suture-like veins colored yellow to yellowish brown. This yellow stain is due to the oxidation of iron pyrite, minute grains of which can be seen along the veins with the aid of a lens.

In White Pine County, about 4 miles west of the Nevada-Utah State line, beginning about 5 miles west-southwest of Gandy, Utah, is an extensive deposit of marble. This marble has been studied and described by Darton,[1] who finds the marble formation to be about 150 feet thick and to extend up a canyon for 2 miles, constituting the greater part of the walls of the main canyon and of several of its branches. The marble is completely crystalline and is in large part dark bluish gray in color, banded or mottled with light gray or white, although a great variety of other colors may be seen. Some beds show regular alternations of white and gray marble in thin wavy or contorted layers, and there is also a portion, about 35 feet thick, of massively bedded creamy-white marble near the top of the deposit. The rock is variable in grain and large quanties of both fine and coarse grained material are available. The rock is mainly a calcite marble carrying small quantities of magnesia, ranging from 1.35 to 5.66 per cent, and less than 1 per cent each of such impurities as silica, iron oxide, and alumina. No pyrite were observed. The rock is reported to be susceptible of a beautiful polish. Physical tests show that the rock possesses a high crushing strength and a low percentage of absorption and should therefore be well suited to exterior structural work as well as interior decoration. Only surface samples had been obtained at the time Darton examined this deposit, the long haul to a railroad having precluded commercial development.

[1] Darton, N. H., Marble of White Pine County, Nev., near Gandy, Utah: U. S. Geol. Survey Bull. 340, pp. 377-380, 1908.

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Limestone.—Limestone, although found in many localities in Nevada, is quarried in only four counties. The chief demand for limestone in this State is for the manufacture of lime, and limekilns have been erected at the places mentioned in the list of limestone quarries. At Dayton the stone is fairly high in calcium carbonate and carries 2.15 to 3.85 per cent iron and aluminum oxides and 4.39 to 7.22 per cent silica. Near Carson City the rock is also a high-calcium limestone, but averages lower in impurities, such as the metallic oxides and silica.

Sandstone.—Nevada has had developed up to the present time only a few rocks of this type, and none of them can be called first class. According to Reid, they are all of Recent geologic age. The first and most important sandstone is the well-known one at the State prison, near Carson. The sandstone beds or strata occupy the site of an extinct lake and exhibit the famous animal tracks on the present floor. The color is a yellowish gray, a gray, unfortunately, streaked with a light yellow, and not uniform. The rock is rather heavily bedded, with the bedding planes nearly horizontal. The mineral content shows the stone to be derived from the weathering and decomposition of a granite, the yellowish tinge being due to the oxidation of the iron-bearing substances. The constituent grains are cemented by a secondary silica. The average grain of the rock is of medium fineness, but in places becomes quite coarse, containing pebbles half an inch in size. The hardness and strength are medium, sufficient for all ordinary needs, and the resistance is good. There is much material in sight. The stone has been used largely in Carson and Reno. The new chemistry building at the university is constructed wholly of it, and presents a very satisfactory appearance. A small quantity has been used in the stone entrance to the university grounds.

Sandstone occurs near the town of Fallon, Churchill County. Little quarrying has been done, but samples of the rock show its main features. In color it is a cream-white very uniform in the small pieces shaped for exhibition. The grain is uniform, and quite fine. Its hardness and strength are about equal to those of the stone near Carson and satisfactory. It should resist the weather well, and ap pears to be a very fair stone for building purposes.

There are two varieties of sandstone quarries near and used in Winnemucca. Neither is first class in any respect, though they do well enough for local uses. They are taken from the old lake beds, to the northeast of the town. One stone is quarried 9 miles from the railroad station and hauled in by team. The color is a light drab and quite uniform. The minerals and substances comprising the stone do not show, on account of the fineness of the grain. Nothing but black flakes of mica are noticed. The hardness and strength are too low for anything but small structures. It stands temperature changes well, and were its strength higher would be an admirable building stone. Some new buildings have recently been erected in Winnemucca composed largely of this stone. The second variety of sandstone occurs at a point 4 miles from town, and is much more available. There are numerous faults and breaks in the material, which render the cost of obtaining stone fit for building almost prohibitive. The color is light gray; the texture is coarser than in the first variety, and somewhat variable. The hardness and strength are

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also considerably greater. The new fire company house in Winnemucca shows a handsome front of this material.

At Elko there is a sandstone much like the first one described from Winnemucca. As with the rest of the soft materials, its use is limited to small buildings, where the strain upon it is light. The local demands are met sufficiently well by it, but it can never have wide use. There is surely much first-class building material to be developed in this part of the State as the population increases.

Production.—The production of stone in Nevada is not published separately for either 1913 or 1912.

Directory.—The quarries of the kinds of rock quarried in Nevada are listed below by class of rock, county, and town (or post office):

Directory of stone quarries in Nevada.

GRANITE.

Mineral County: 1. Luning.

Washoe County:
2. Washoe.
3. Reno (5 miles west of).

LIGHT VOLCANIC ROCK.

Esmeralda County: 1. Near Tonopah, Nye County.
Ormsby County: 2. Merrimac.

Washoe County:
3. Reno (1 mile north of.)
4. Reno (2 miles southwest of.)

MARBLE.

Clark County: 1. 14 miles north of Las Vegas.

Mineral County:
2. Luning (2).
3. Mina (2).
Nye County: 4. Carrara.

LIMESTONE AND LIMEKILNS.

Clark County: 1. Sloan.
Lyon County:
2. Dayton.

Lyon County—Continued.
3. Wabuska.
Ormsby County: 4. Carson City.

SANDSTONE.

Ormsby County: 1. Carson City.

IDAHO.

By G. F. Loughlin.

Idaho, as shown on the geologic map of North America, may be divided geologically into seven parts. The part north of the latitude of Moscow consists mostly of an extensive area of the Algonkian Belt series, and includes in its western part a considerable area of metamorphic Paleozoic strata. These formations at many places are cut by bosses of granitic rocks and by sills and dikes of diabase and amphibolite. The central part of the State is covered by an immense batholith of granite or granodiorite, of late Cretaceous age, which incloses several areas of pre-Cambrian gneiss and schist. Paleozoic rocks occur extensively east of the southern end of the granite batholith, and also in the Great Basin ranges which occupy the southeastern part of the State. They are also exposed in limited areas along Snake River and certain tributary canyons, where overlying formations

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have been removed by erosion. Triassic and Jurassic formations occur to a considerable extent along Snake and Salmon River basins in the western part of Idaho County, and also near the eastern boundary of the State from St. Anthony southward, where they are accompanied by Cretaceous rocks. Tertiary sediments, for the most part only imperfectly consolidated, are present along the valleys of Snake and Payette rivers near Boise, and also in Lemhi Valley from Salmon southward. Light volcanic rocks of early Tertiary age, rhyolitic and andesitic flows and tuffs, are known to be abundant in the mountains between the Snake River valley and the south and east boundaries of the State. The great Columbia River basalt field, of late Tertiary age, occurs in the western part of the State north of Lewiston and as far south as Weiser. It is present near Nampa in the southwestern part of the State, extending eastward along the Snake River valley to and beyond Pocatello, and is also exposed in the valley at Idaho Falls. Most of these formations have been quarried to some extent, but thus far only two or three quarries in the whole State have furnished stone for more than local use.

Granite.—In Idaho the word granite has been commercially used to include basalt and light volcanic rocks, but in this report these will be considered separately. Besides the immense batholith of central Idaho, granite and the closely related types granodiorite and monzonite are present in relatively small intrusive bodies cutting Paleozoic and older rocks in the northern part of the State and at several places along canyons in the western part, where they are exposed beneath the overlying basalt; but at only a few places are there exposures of granite of good quality near enough to lines of transportation to be of any present commercial value. It is in large part of similar character to the granite so widely distributed in the Pacific States, and for this reason is not likely to find more than a local market.

No granite quarries in the State have been steadily or extensively worked. The only quarry prospects of which the United States Geological Survey has any record are those situated along Snake River about 25 miles above Lewiston, or 6 or 8 miles above the mouth of Grande Ronde River, and one at the head of Hulls Gulch, 5½ miles east of Boise. According to Russell[1] the stone on Snake River, which has been quarried at two or three localities, is a fine-grained granite (diorite or monzonite) of excellent quality, and occurs in unlimited quantities. The limited excavations seen were not sufficient to demonstrate the full value of the quarries, but they indicated that large-sized blocks of homogeneous stone could probably be obtained. Others who have seen the quarries state that fracturing is so abundant that quarrying must be expensive and involve the handling of a large quantity of waste. The quarries, located on each side of the river, close to its margin, are favorably situated in reference to water transportation at periods of high water, but are 2 miles or more above the present limits of permanent navigation. Attempts to market some of the stone in recent years have involved a cost far in excess of the selling price. Conditions in the future may be made more favorable if a proposed railroad is finally built along the Snake

[1] Russell, I. C., Geology and water resources of Nez Perce County, Idaho: U. S. Geol. Survey Water-Supply Paper 54, p. 119, 1901.

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River canyon. The rather dark-gray color of the stone practically limits it to monumental work, for which it appears very well adapted, provided blocks of desirable size and free from black knots or blotches can be obtained.

Russell also mentions a rather coarse-grained diorite of good quality on Mission Creek, where it cuts through Craig Mountain and near Kippen, 20 to 25 miles southeast of Lewiston, but both of these localities lack transportation facilities. He describes a similar diorite as occurring in vast quantities in Clearwater Canyon, from near Orofino to a point above Kamiah. It is easily available for rough masonry, but is too jointed and veined to afford large blocks of uniform color and texture. Transportation facilities, however, are favorable, and rock suitable for building and monumental work may be discovered.[1]

The southwestern portion of the great central batholith extends to within a few miles of Boise, but, according to Lindgren,[2] it is rarely available as building stone on account of its deep disintegration and the extensive joint systems traversing it. At most places where it is well exposed the remoteness of the locality renders it of small value. A small quantity has been quarried at the head of Hulls Gulch, 5½ miles east of Boise, and may be seen in use at the side entrance to the post office and the entrance of the Commercial Club in Boise. It is a gray medium to rather coarse grained granite, more or less porphyritic. Only a few residual bowlders and superficial joint blocks in ledges have been worked thus far, but the quality of these and favorable transportation costs justify further development. The stone in sight will mostly afford rather small blocks, but blocks up to 8 or 10 feet in length and 2 feet square in cross section are obtainable.

Another occurrence which deserves mention because of its favorable location and architectural value is that of a rather coarsely porphyritic granite, which is exposed at a number of places on the Great Northern and the Northern Pacific railways, southwest of Sandpoint, in Bonner County. It is characterized by feldspar phenocrysts from half an inch to 1½ inches long, in a medium to rather dark gray groundmass of quartz, feldspar, and considerable biotite. It is of generally similar appearance to the granite in the post-office building at Spokane, Wash.

Diorite or "black granite" forms numerous intrusive sheets in the slates and sandstones along the Great Northern Railway, between Bonners Ferry and Lenia, but its architectural value has not been investigated. It is very dark, somewhat greenish, and rather coarse to fine grained. Greenish black hornblende, somewhat fibrous, is the most conspicuous mineral, and feldspar and quartz are also prominent.[3]

Dark volcanic rocks (basalt).—Basalt occurs so extensively in Idaho, Washington, and Oregon, and is so restricted by its structure and appearance to use for rough building and crushed stone, that it has been most economical for users of this stone to open temporary quarries within easy reach of the point of use. There are no permanently

[1] Russell, I. C., op. cit., p. 119.
[2] Lindgren, Waldemar, U. S. Geol. Survey Geol. Atlas, Boise folio (No. 45), 1898.
[3] Calkins, F. C., A geological reconnaissance in northern Idaho and northwestern Montana: U. S. Geol. Survey Bull. 384, p. 45, 1909.

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active quarries in Idaho, and the symbols on the accompanying map only serve to show the places of which the Geological Survey has record where basalt has been used at one time or another. The stone used is typical basalt. Some is rather highly vesicular, some is dense, with only occasional rather larger vesicles. By far the greater part has been used as crushed stone in concrete work and road building. For the latter use there may be considerable variation in the quality of the stone; some is rather brittle, owing to its texture or to minute fractures, and some is soft in places owing to decomposition and causes the road surface to wear unevenly, whereas the best stone is of practically ideal toughness and homogeneity and wears with an even surface. Good stone is doubtless abundant everywhere, but experience has shown that care must be used in the selection of stone for high-class road work.

Basalt has been extensively used as rubble and in the side and rear walls of many buildings, where the colors and shapes of the blocks were of no great consequence. Dressed blocks have also been used in a few cases. The Zion Cooperative Mercantile Institution building at Idaho Falls, built in 1884, has a front entirely of basalt in dressed blocks, with both rock face and finely tooled surface; some blocks are 6 feet long. The stone is of nearly black color and contains several small to large irregularly spaced vesicles. It gives a somber appearance, but shows no weathering effects after 30 years of exposure, and door sills where loaded trucks have been passing back and forth have not suffered any noticeable abrasion. Basalt has also been used, and with good effect, in the base of the Methodist Episcopal church, at Lewiston, erected in 1907. Here the blocks are mostly small, with rock face exposed.

Light volcanic rocks.—Light volcanic rocks, called sandstones in some places, have been used considerably for building in the southeastern part of the State, and are well illustrated by buildings in Pocatello, Blackfoot, Idaho Falls, and Rexburg. The stones used are mostly rhyolite, but a little andesite (and trachyte) as well as volcanic tuffs have been worked. The quarries between Blackfoot and Rexburg are mostly of rhyolite, which occurs in residual bowlders of gray and pink colors. It affords mostly stone of small dimensions, but can yield blocks as much as 10 feet in length and 3 to 4 feet in width and thickness. There has been, however, little demand for such large blocks, and most of the stones in use range from less than 2 to 4 and occasionally 5 or 6 feet in length, the latter forming sills and copings. Scattered vesicles and occasional included spots of flinty matter and rather pumicious material are commonly present, and are to be expected in this type of rock; but they give no seriously objectionable appearance to stone with rock face or coarsely pointed surface. Tuffs are quarried at Sunnydell in Madison County and near Albion in Cassia County, and have also been worked at Goshen, south of Idaho Falls. In most cases both the true rhyolites and the tuffs work very easily when quarried, but gradually harden on prolonged exposure, and in the favorable climate of southeastern Idaho they have withstood the weather from 15 to over 20 years with no evidence of disintegration. A few of the tuffs, however, are so poorly consolidated in the first place and undergo so little hardening on exposure that they have crumbled considerably in the walls of buildings, or have been deeply worn where subjected even to slight abrasion, and have suffered transverse breaks even under a light load.

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Light volcanic rocks of these types should not be expected to give as high results in testing as do granite, marbles, and the stronger sandstones; but building experience in southeastern Idaho has proved that the better grades, both of the flow rocks (true rhyolites, andesites, etc.) and of the tuffs are quite adequate for all the demands that have been made upon them. They, furthermore, are so cheaply worked, rough stone selling as low as $2 a perch (16½ cubic feet) and dressed stones from 20 to 35 cents a cubic foot, according to size, that they seem worthy of more than local consideration.

A little rhyolite, which forms sills or contemporaneous flows in the Tertiary sands (Payette formation) around Boise, has been used to a limited extent for local buildings and also for roads, but none has been quarried for several years.

A basaltic tuff of brownish-yellow color, and therefore classed with the light volcanic rocks has been used in several buildings in Lewiston. It is, however, quarried on the west side of Snake River and is described with the volcanic rocks of Washington on page 1401.

Slate.—According to Russell:[1]

> Slate of pleasing reddish color, of easy cleavage, and so far as can be judged from natural exposures, of good quality, occurs on the eastern side of Cottonwood Butte (about 40 miles southeast of Lewiston), and is well located for quarrying. This material should be thoroughly tested as soon as transportation facilities admit of its being put on the market, to ascertain whether sheets of the desired size can be obtained.

Russell's statement was made before the railroad from Joseph to Orangeville had been constructed. The deposit is now only about 5 miles west of Cottonwood station. It is of interest in this connection to note that no red slate quarries have been developed in the Western States.

Slate occurs abundantly in the Belt series of northern Idaho, but none of it has been found to possess the necessary qualities of roofing slate.[2]

Marble.—Crystalline limestone and dolomite occur at several places in Idaho, but the exposures thus far noted are either too badly fractured or are too remote from transportation lines to be of present commercial interest as marbles. Only two marble prospects in the State have been reported to the United States Geological Survey. One of these is situated on Snake River about 25 miles south of Lewiston. Small samples seen by the writer consist of white coarse-grained calcite, irregularly streaked with dark graphitic bands and lenses, and resembling the darker varieties of the well-known marble from Georgia. The rocks in this vicinity are much disturbed, and it is not known whether blocks of sufficient size and quality for architectural use can be readily obtained. The deposit at present, as is the case with the granite in the vicinity, is not yet within reach of permanent water transportation.

The other marble prospect is located at Basin on a belt of crystalline limestone which extends along the range west of Albion in Cassia County. The nearest railroad point is Oakley, about 5 miles to the west. One block of it seen in Albion was a white, coarse-grained stone containing a large proportion of tremolite in single-bladed crystals and diverging groups up to an inch in length. This one sample, which may not fairly represent the whole deposit, is of quite as good appearance as some white tremolitic marbles that have found

[1] Op. cit., p. 122. [2] Oral communication from F. C. Calkins, of the U. S. Geological Survey.

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considerable use, but is hardly of sufficient quality to warrant extensive development under present conditions of transportation.

According to Russell,[1] the white to gray crystalline limestone at Orofino and vicinity polishes well and "should find a ready market for building and monumental purposes provided it can be had in blocks of desired size"; but so far as known no attempts to develop a marble quarry have been made. The deposit is close to the railroad and favorably situated for transportation to the large cities of the northwest.

Limestone.—Limestone is widely distributed in Idaho and has been quarried at a number of places, mostly for lime manufacture, but in a few places for sugar refining and for smelter flux, and in one instance for cement manufacture. Talus from shattered limestone has been used locally for road building.

The principal lime-producing point at present is at Bayview on the southwest shore of Pend Oreille Lake. The quarries are in shattered, white, coarsely crystalline limestone of probable Paleozoic age. Four quarries have been opened, but only one is being worked at present. Beds of high calcium and high magnesium content (the latter called "soft rock") alternate irregularly and are accompanied by thin beds and streaks of dark lime silicate rock. Only the high-calcium rock has been quarried thus far. The stone is white, rather coarse grained, and appears to be pure save for thinly but evenly disseminated specks of pyrite. When dissolved in weak hydrochloric acid it leaves a small residue which the microscope shows to consist chiefly of the lime-magnesia silicates, tremolite and diopside. The pyrite, during burning, oxidizes to brownish black specks, which are of insufficient quantity to affect the quality of the lime. The high magnesium rock is called "soft rock" because of its tendency to crumble on exposure to the air after burning. The following analysis, made for the Washington Brick, Lime & Sewer Pipe Co., of Spokane, Wash., shows the composition of both the high-calcium and the high-magnesium stones and the corresponding burned limes:

Analysis of limestones from Bay View, Idaho.

	1	2	3	4	5
Silica, mica, clay, etc	0.8	2.3	2.2	5.1	2.4
Iron oxides and alumina	None.	0.2	Trace.	Trace.	None.
Calcium carbonate	93.2	60.0	56.0	60.5	92.3
Magnesium carbonate	5.8	37.7	43.5	34.6	5.6
	99.8	100.2	101.7	100.2	100.3

Approximate composition of lime burned from limestone, Bay View, Idaho.

	1	2	3	4	5	6
Silica, mica, clay, etc	1.4	4.3	2.2	9.3	4.2	2.08
Iron oxides and alumina	None.	0.4	Trace.	Trace.	None.	0.76
Calcium oxide (CaO)	93.5	62.3	58.5	60.3	90.3	87.61
Magnesium oxide (MgO)	5.4	33.0	38.2	30.0	5.6	6.48
Ignition loss						3.40

1. Top of quarry at the kiln.
2. Ten feet down on face "soft rock."
3. Side of quarry 20 feet down, "soft rock."
4. Blue rock. Forms thin bed at or near bottom of high-calcium bed.
5. From old quarry, near lake shore.
6. Location not given. Presumably an average sample of burned lime.

Analyses 1-5, by T. R. Ernst, 1911; analysis 6 by the C. M. Fassett Co.

[1] Russell, I. C., U. S. Geol. Survey Water-Supply Paper 54, p. 120, 1901.

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As many as five kilns have been operated in the past, but present demands require the operation of only one. The lime is loaded on cars at the kiln and shipped over the Spokane International Railway, which has a branch terminus at Bayview. Across Pend Oreille Lake, about a mile northeast of Lakeview, an impure limestone is quarried, crushed, and loaded into cars, which are conveyed across the lake on a scow to Bayview and thence by rail to the International Portland Cement Co.'s plant east of Spokane. Shale for the cement plant is also quarried at the same locality as the limestone. At Lakeview limestone was formerly quarried, and the remains of two old kilns are still standing. Limestone outcrops at several other points along the shores of Lake Pend Oreille and has been quarried in a small way at a few places, but the present small demand for lime gives no incentive to work deposits situated so far from a railroad.

At Orofino lime has been burned in the past, but the property has recently (June, 1914) been taken over by a cement company, whose plant is not yet completed. The deposit is described by Russell [1] as follows:

> Limestone occurs also at Orofino and at three or four localities on Orofino Creek within the first mile above its mouth, as well as on the southern side of Clearwater River about half a mile below Orofino. At each of these localities the well-defined beds are associated with schist; they strike about north-south and stand nearly vertical. The limestone has been metamorphosed and is now mostly a coarsely crystalline marble, varying in color from white to gray.

An analysis of this limestone is given in column 5 of the accompanying table.

Russell [2] states that limestone occurs in great quantities along the Snake River Canyon, 1 to 3 miles above the mouth of Grande Ronde River and also about 8 miles farther up stream (that is about 18 and 26 miles south of Lewiston, or 5 and 13 miles south of Taplin). The deposit near Grande Ronde River has been worked for limestone, and is at present in control of the Idaho Portland Cement Co., which has a partly erected cement plant at Asotin, Wash. Shale suitable for cement manufacture also occurs in the same locality. The deposit was examined in 1912 by H. S. Gale,[3] who took samples which yielded the analyses in columns 1 and 2 of the accompanying table. An analysis of a sample collected by Russell is given in column 3. All three analyses show the rock to be a high-calcium limestone of exceptional purity. Gale states that Snake River at this point is navigable for eight months in the year. Small boats may be able to reach it all the year around.

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[1] Russell, I. C., op. cit., p. 120.
[2] Idem, pp. 120–121.
[3] Mr. Gale's report is included in U. S. Geol. Survey Bull. 522, pp. 136–138, 1913, on the Portland cement materials and industry in the United States.

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Analyses of limestone near Snake River, Idaho.

	1	2	3	4	5
Silica (SiO_2)	0.48	0.34	0.39	1.08	0.37
Insoluble				.11	.27
Oxide of iron (Fe_2O_3)	Trace.	Trace.	.10	.19	.12
Alumina (Al_2O_3)	.48	.18			
Lime (CaO)	55.52	55.72	55.34	54.75	51.96
Magnesia (MgO)	.17	.43	.10	.51	3.05
Carbon dioxide (CO_2)	43.07	43.20	43.59	43.50	44.08
Water (H_2O)	Trace.	Trace.			
Alkalies and undetermined	.28	.13			
	100.00	100.00		100.14	99.85

1. Average of 121 samples of limestone chipped at approximately uniform intervals throughout the length of a 160-foot tunnel.
2. Average of about 30 samples representing an outcrop at least 50 feet thick.
Samples Nos. 1 and 2 collected by H. S. Gale, U. S. Geol. Survey, and analyzed by A. B. Lort, Bur. Standards.
3. Sample from Snake River Canyon, collected by I. C. Russell and analyzed by George Steiger.
4. Sample from Mission Creek.
5. Sample from Orofino.
Samples 4 and 5 collected by I. C. Russell and analyzed by W. F. Hillebrand. The insoluble portions contained a trace of titanium oxide (TiO_2). Both analyses showed traces of organic matter.

Russell also gives the following description of a limestone on Mission Creek about 20 miles southeast of Lewiston:[1]

Limestone outcrops beneath the Columbia River lava on the right bank of Mission Creek, about half a mile above where it emerges from the deeper portion of its canyon in the Craig Mountains uplift, and also in a gulch about a mile to the west. Along Mission Creek, for a distance of approximately 300 feet, the limestone is admirably exposed in the precipitous canyon wall to a height of 500 feet. It is in general a hard grayish-blue rock containing a few obscure fossils. The strike of the beds is N. 50° E. (magnetic), and the dip is eastward at an angle of from 80° to 85°. Formerly it was burned in kilns which still remain, and it is said to have yielded a good lime.

An analysis of a typical sample of this rock is given in column 4 of the preceding table, and shows it to be, like the limestone in Snake River Canyon, a high-calcium rock of exceptional purity and to be well suited not only for lime burning but also for use in the manufacture of Portland cement and in the beet-sugar industry.

Transportation difficulties have been the chief obstacle to successful exploitation of this deposit.

North of Boise, on a point between the north and the south forks of Willow Creek, there is, in the Payette formation, a stratum of yellowish-gray oolitic limestone several feet thick which has been locally used for building stone. It consists almost exclusively of concentric spheroids of calcite about 1 millimeter in diameter, sometimes with small particles of foreign substances in the center.[2]

Limestone has been quarried at several places in the southeastern parts of the State mostly, or wholly, from Paleozoic formations, though limestones of Triassic and Jurassic age are available near the east boundary between Montpelier and St. Anthony. Of the quarries indicated on the accompanying map, those at Arco, in Blaine County, and at Franklin, in Franklin County, have been worked in connection with the beet-sugar industry, those at Hahn and Nicholia for smelter flux, and the others for lime burning. Most of the quarries are idle at present and but little information regarding these limestones could be obtained. A few analyses are, however, given below. In the vicinity of Montpelier and Georgetown in Bear Lake County both talus piles

[1] Op. cit., p. 121. [2] Lindgren, Waldemar, U. S. Geol. Survey Geol. Atlas, Boise folio (No. 45), 1898.

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and outcrops of shattered limestone have been used for local road building. The stone is naturally broken into sizes desirable for macadam and has only to be shoveled into carts and conveyed to the point where it is to be used.

There are large areas of limestone in the vicinity of Mackay, Custer County, and of Hailey, Blaine County, but no quarries have been reported from them.

Small travertine deposits have been quarried at a few places and used for flux in smelters at Clayton, Lemhi County, and at Ketchum, Blaine County.[1]

Analyses of limestones from Blaine,[a] Cassia, and Franklin counties, Idaho.

	Arco (Blaine County).[b]			Franklin (Franklin County).[c]	Burley (Cassia County).[d]
Insoluble	1.90	2.04	1.34		
Silica (SiO_2)				1.78	1.09
Soluble silica (SiO_2)	.06	.02	.09		
Iron and aluminum oxides (Fe_2O_3 and Al_2O_3)	.28	.38	.34	.30	Trace of each.
Lime (CaO)	55.10	54.78	54.52		
Magnesia (MgO)	.07	.13	.34		
Sulphur trioxide (SO_3)	.10	.03	.10		
Water (H_2O)				.08	
Ignition loss	43.14	42.94	43.34		
Undetermined				.40	
	100.65	100.32	100.07		
Calcium carbonate ($CaCO_3$)	98.4	97.8	97.40	93.56	97.29
Magnesium carbonate ($MgCO_3$)				3.88	

[a] Limestones used in beet-sugar manufacture.
[b] Furnished by Utah-Idaho Sugar Co., Salt Lake City, Utah.
[c] Furnished by Amalgamated Sugar Co.
[d] Furnished by Barrett Lime Co.

Sandstone.—Although sandstone has been reported to be produced at several localities, most of the stone in question is in reality light volcanic rock. At only one locality, around Boise, has true sandstone been worked at all extensively, and at only one other locality, east of Dingle in Bear Lake County, has a sandstone prospect of any promise been brought to the Survey's attention.

The sandstone around Boise belongs to the Payette formation of Tertiary (Eocene ?) age, which consists for the most part of loosely consolidated sands and clays with some beds of hard sandstone. A detailed description of the formation has been given by Lindgren.[2]

The hard sandstone beds are found at several places and some of them are of excellent quality. Lindgren says:

> At all of the localities where good sandstone occurs the quality appears to be the result of the cementing action of hot siliceous springs on the sands. The principal locality near Boise is Table Rock, the sandstone occurring in the eroded hills of the Payette formation from Hot Springs on the south to a point northeast of Natatorium on the north. At Table Rock the facilities for quarrying are excellent, and many buildings at Boise are constructed of the material. There are two principal strata, 50 to 100 feet thick, one at the top of Table Rock, the other 400 or 500 feet below it, separated by less firmly cemented material. * * * The sandstone is of light gray, yellowish, or reddish color. The best quality is found in the lower strata, as the top layers are often somewhat too coarse. The rock is easily dressed and is well adapted for building purposes. It is composed of closely packed angular quartz and feldspar grains, the latter often filled with secondary mica. Foils of original biotite and muscovite also occur. There is little if any pyrite present. The rock is very porous, containing extremely little cementing material.

[1] Oral information by J. B. Umpleby, United States Geological Survey.
[2] Lindgren, Waldemar, U. S. Geol. Survey Geol. Atlas, Boise folio (No. 45), 1898, and Nampa folio (No. 103), 1904.

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There is at present one quarry of considerable size at the south end of the top of Table Rock. The sandstone bed here consists of a 20-foot thickness of good stone capped by a varying thickness of coarse, hard, pebbly sandstone, and underlain by a poorly consolidated argillaceous stratum. The stone has been quarried for a total distance of a quarter of a mile along the south edge of the deposit and cubical blocks of good stone measuring as much as 20 feet on a side have been loosened. The blocks are bounded by vertical joints at approximately right angles and rather uniformly spaced. The present method of quarrying is to undermine a block by removal of the underlying material, and to allow it to fall over on the quarry floor. The force of the fall is sufficient to cause the top waste rock to separate from the block along a rather pronounced seam and to break into pieces small enough to be conveniently handled. The good stone is then divided by the Knox system of blasting into blocks of desired size, lengths usually ranging up to 10 feet and widths and thicknesses from 2 to 4 feet, and is shipped down the mountain on a gravity road a mile long to a spur track on the Oregon Short Line Railroad. The upper 6 or 8 feet of the 20 feet are rather conspicuously streaked with brown iron oxide and are called second-class stone; the lower 12 or 14 feet are relatively free from these streaks and are called first class. The difference in appearance, however, is conspicuous only in newly quarried stone, and the film of dust which has accumulated on the stone after only two or three years of exposure in the buildings of Boise is sufficient to conceal the difference between first and second class stone.

The following results of crushing tests on the sandstone at Boise have been furnished the writer by Prof. C. N. Little of the University of Idaho, Moscow:

Crushing tests of the sandstone at Boise, Idaho.

In 1911:
- One 2-inch cube, gray sandstone; crushing strength 5,600 pounds per square inch.
- One 2-inch cube, cream sandstone; crushing strength 5,500 pounds per square inch.
- Greatest difference in edge perpendicular to pressure, $\frac{1}{64}$ of an inch.

In 1912:
- Eight 2-inch cubes from same quarry; crushing strength ranging from 2,800 to 4,210 pounds per square inch.
- Average for light cream sandstone 3,650 pounds per square inch.
- Average for cold gray sandstone, 3,460 pounds per square inch.

Dimensions varied as much as 0.02 of an inch perpendicular to pressure face.

These figures may be rather low since the blocks tested were not perfect cubes. They serve, however, to give an approximate idea of the strength of the stone. It is weaker than several well-known sandstones, but the many buildings constructed of it in Boise show that it is quite strong enough to meet all the strength requirements thus far demanded of it. Its weathering qualities in the Boise climate are also very satisfactory.

Its use thus far has been largely local, and there are no data at hand regarding its durability in other regions. The stone in recent years has begun to find a more extended market, and some has been shipped as far as Los Angeles, Cal.

Besides the quarry just described, small quarries have been worked in the penitentiary grounds at Natatorium and in Curlew Gulch, 2

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miles northeast of Boise. Other deposits, more or less remote from the railroad, are at Horseshoe Bend on Payette River, "Table Mountain" on the north side of Willow Creek, and southwest and south of Nampa.

The prospect near Dingle lies about 5 miles southeast of Dingle village and 3 miles southwest of Harer (Hear) siding on the Oregon Short Line, near the head of Pine Springs Gulch. The deposit is a part of the Nugget sandstone, of Jurassic or Triassic age, and is exposed along the north side of the gulch for a height of 400 or 500 feet, the beds striking a little west of north and dipping 35° to 50° W. The stone is fine, even grained, and nearly all of light reddish brown color, some of uniform appearance, and some with conspicuous thin bands of light and dark brown and occasionally of creamy white. At the east end of the exposure is a thin-bedded outcrop of creamy-white sandstone with little or no brown coloring matter. The constituent grains are quartz with considerable feldspar, and the principal cementing materials appear to be silica and ferric oxide. The outcrops are largely of thin-bedded appearance, owing to more pronounced weathering along certain seams or bedding planes. Single layers range from a few inches up to 1, 2, and 3 feet in thickness. It is probable that these seams will not be so conspicuous below the weathered surface and will not prevent the quarrying and use of thicker blocks. Near the west end of the property, blocks measuring 5 feet or more in thickness and 10 feet or more in length are exposed in the broken outcrops at three or more distinct horizons. Thus far only talus blocks have been quarried, furnishing mostly small blocks of less than 3 feet in length and a foot or less in thickness; but some finished blocks 6 feet or more in length have been dressed for steps, copings, and sills.

The only test thus far made on the stone was a crushing test of a 2-inch cube by Prof. Solon Shedd, at Pullman, Wash., which was found to have a crushing strength of 12,000 pounds to the square inch, a much greater strength than is possessed by several well-known sandstones. The only example of the stone seen in use is the dwelling house on Ream's ranch, Dingle, where the stone has been in place for 10 years with no sign of weathering. In view of the scarcity of stone of this color in the Northwest, this prospect is well worthy of consideration.

Production.—The total production of stone in Idaho in 1913 was valued at the quarries at $152,390, as compared with $63,974 in 1912.

Directory.—The quarries of all kinds of rock quarried in Nevada are listed below by class of rock, county, and town (or post office):

Directory of stone quarries in Idaho.

GRANITE.

Ada County: 1. Boise (5½ miles east of).
Nez Perce County: 2. Lewiston (25 miles south of).

DARK VOLCANIC ROCKS (BASALT).

Bonneville County: 1. Idaho Falls.
Canyon County: 2. Warren (near Nampa).
Idaho County: 3. Cottonwood.
Kootenai County: 4. Coeur d'Alene.
Nez Perce County: 5. Lewiston.
Twin Falls County: 6. Twin Falls.

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LIGHT VOLCANIC ROCKS.

Ada County: 1. Boise (foothills east of).
Bonneville County:
2. Goshen.
3. Prospect and Rigby (2).
Cassia County:
4. Albion (6 miles southeast of).
5. Oakley.
Madison County:
6. Rexburg (5 miles southeast of).
7. Sunnydell (2).

MARBLE.

Cassia County: 1. Basin.
Nez Perce County: 2. Lewiston (25 miles south of).

LIMESTONE.

Blaine County: 1. Arco.
Bonner County: 2. Lakeview (3 miles northeast of).
Franklin County:
3. Franklin.
4. Mission Creek.
Nez Perce County: 5. Taplin (5 miles south of).

LIMESTONE AND LIMEKILNS.

Bannock County: 1. Pebble.
Bear Lake County: 2. Montpelier.
Cassia County:
3. Basin.
4. Burley (14 miles southeast of).
5. Marion.
Franklin County: 6. Clifton.
Fremont County:
7. St. Anthony.
8. Teton.
Kootenai County: 9. Bayview.
Lemhi County:
10. Hahn.
11. Lemhi.
12. Nicholia.
Nez Perce County: 13. Oro Fino (or Orofino).
Oneida County: 14. Malade City (2).

SANDSTONE.

Ada County: 1. Boise (4 miles southeast of) (2).
Bear Lake County: 2. Dingle.

OREGON.

By E. F. Burchard.

A strip along the Pacific slope, comprising less than one-fourth of the area of Oregon, is largely composed of sedimentary rocks, of which sandstone of Tertiary age is probably the predominant type. In southwestern Oregon Cretaceous and Jurassic rocks as well as Silurian and undifferentiated Paleozoic sediments occur, the Paleozoic sediments carrying in places valuable beds of limestone and marble. Two or three small areas of intrusive rocks including granite are found in southwestern Oregon. By far the greater part of the State east of the Pacific slope is underlain by effusive rocks of Tertiary and later age, although in the interior of the State, surrounded by the volcanic rocks, are large areas of Tertiary sediments, such as the John Day region, and of Quaternary deposits, such as the arid regions of south-central Oregon. A few small areas of Paleozoic sedimentary and intrusive rocks also occur within the volcanic field of northeastern Oregon.

The stone industry has not yet reached a high state of development in Oregon, although certain Tertiary sandstones have been quarried on a fairly large scale and have been shipped as far as San Francisco.

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The granites of the southwestern part of the State are now attracting attention. Limestone is quarried in several places for crushed stone and at a few places for the manufacture of lime, and, according to recent reports, will soon be used for the manufacture of Portland cement. The output of basalt in the Willamette Valley is of growing importance, especially for road metal and concrete.

A few papers devoted particularly to stone resources of Oregon are available, among which are:

Stafford, O. F., Mineral resources and industries of Oregon: Oregon Univ. Bull., new ser., vol. 1, No. 4, pp. 105–111, May, 1904. (Stone notes mainly by C. W. Washburne.)

Darton, N. H., Structural materials in parts of Oregon and Washington: U. S. Geol. Survey Bull. 387, 1909.

Parks, H. M., Preliminary report on building stone in Oregon: The mineral resources of Oregon, vol. 1, No. 2, pp. 10–46, February, 1914.

From these papers, supplemented by data published by J. S. Diller in descriptions of the Roseburg, Coos Bay, and Port Orford quadrangles, United States Geological Survey folios Nos. 49, 73, and 89; and in a geological reconnaissance in northwestern Oregon in the Seventeenth Annual Report of the United States Geological Survey, pp. 441–520; by A. J. Collier, in the geology and mineral resources of the John Day region, in the mineral resources of Oregon, volume 1, No. 3, pages 3–47, March, 1914; and from field notes of the writer, the following notes on the stone resources of Oregon are derived:

Granite.—Important deposits of granite exist in several places in Jackson County within moderate distances of the main line of the Southern Pacific Railroad. A very excellent grade of granite outcrops on Neil Creek, about 1½ miles southwest of Ayers station. Granite underlies several square miles in this locality and is part of the granite intrusion of Mount Ashland. Much of this granite has been quarried from large bowlders high on the slopes of Neil Creek and worked into monumental stock at Ashland. Fine examples may be seen in the Ashland cemetery. This granite is medium fine grained, light bluish gray rock, and consists principally of orthoclase, plagioclase, and biotite. It is uniform in texture and color, fractures smoothly for granite, works well, and gives good contrasts between polished and hammered surfaces.

The rock has a sparkling or "lively" appearance, and is almost free of knots or other objectionable features, but contains here and there "salt streaks"—thin veins or dikes that resemble the aplite dikes in the granites of Maine. Joints cut the rock at intervals from a few inches to 6 feet apart, but mostly the spaces are 3 to 4 feet in one direction and much farther apart in another. This granite resembles the well-known Barre, Vt., granite and should prove a valuable resource when the demand for such a stone on the Pacific coast becomes sufficient to maintain a large quarrying industry.

In the vicinity of Medford are several granite quarries. One of these is favorably situated on the Southern Pacific line between Ray Gold and Tolo. A gray granite darker in color and coarser in grain than the stone of Mount Ashland is quarried here. Quartz, orthoclase, and plagioclase, biotite, and hornblende are present. Quarry operations are reported to have been handicapped by the irregularity of the jointing, but some building stone has been obtained here and

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used in the construction of a business block in Medford. The quarry is now operated by Jackson County as a source of road metal. Another gray granite is quarried at points respectively 5 and 6½ miles northwest of Medford. This granite is coarser grained than the stone near Ray Gold, and shows on polished surfaces a peculiar concentric structure in many of its feldspar crystals. A few "knots" or segregations of dark minerals are present in places in the quarry. The product of these quarries is hauled by wagon to Medford, where it is used mainly for monuments, although a small quantity is supplied for structural purposes.

Granite is quarried in eastern Oregon at only one place, viz, about 2 miles east of Haines, Baker County. According to Parks, this is a medium grained rather dark gray granite, the dark color being due to a considerable proportion of black minerals such as biotite and hornblende. Dark-colored knots occur in places in the quarry face. Joints are so spaced that single blocks 3 by 4 by 20 feet may be obtained. The stone is used principally for monuments and foundations, but it is suitable also for general structural purposes. Among the granitic rocks mentioned by Parks is an altered, medium-grained diabase, of a dull grayish-green color and a somewhat mottled appearance that outcrops about 6 miles north of Willamina, Yamhill County. This rock could be used locally to good advantage in piers, foundations, etc., but it is doubtful if it would meet the market requirements for a general building stone.

Physical tests of the Ashland, Ray Gold, and Haines granites showed them all to sustain a pressure of more than 13,000 pounds per square inch. None showed as much as 0.25 per cent of absorption, and no deterioration was apparent after repeated freezing and thawing.

Dark volcanic rocks (basalt, etc.).—Prior to 1913 in statistical tables in Mineral Resources on production of stone in Oregon, basalt, andesite, rhyolite, and all other igneous rocks of Oregon have been grouped under the general term "granite," and the totals for granite thereby greatly exaggerated. The fact is that the greater part of the stone output for the State during the last few years has really consisted of basalt and other dark volcanic rocks, which have been crushed for road making, concrete, and railroad ballast and also sold as rough, broken stone for riprap, chiefly along Columbia River. The statistics have been revised for this issue. As stated above, basalt flows cover a large part of the area of Oregon. The rock varies greatly in character from place to place and is, in general, suitable for the uses above mentioned rather than for dimension stone. According to Washburne, basalt is frequently used as a foundation stone in Oregon, but is undesirable for exterior use on account of the rapidity with which it weathers. He considers that the finest-grained basalts, which are usually somewhat glassy when fresh, are the most durable, but they are generally so fractured that large blocks can not be quarried. Basalt, especially in large columns, makes artistic fences, and when crushed and screened is better for macadam than any other rock in western Oregon. Washburne mentions a good basalt as quarried near Silverton, Marion County, and used in foundations of mills and stores; also a dark basic andesite quarried at Montavilla, near Portland, from which stone is shipped throughout the Willamette Valley for use chiefly as tombstone bases, but used also for building stone,

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although it does not well resist the weather. What is probably the same rock was determined by Johannsen for Darton to be basalt with dibasic texture, consisting of much plagioclase with some augite, magnetite, and phenocrysts of fresh olivine. The highlands west of Portland consist largely of basalt which outcrops extensively in their steep eastern slope and in all of their deeper canyons. The black "basalt" quarried on the banks of Columbia River at St. Helens may be classed as an augite andesite. Southward from Portland the basalt is extensively exposed along the sides of Willamette River beyond Oregon City, where the falls are formed by high ledges of basalt. Basalt occurs at many places farther south in Willamette Valley and is reported to be quarried at Lafayette, McMinnville, Dayton, Amity, Salem, and Cottage Grove. An old quarry at Eugene affords a fine example of columnar jointing.

At Astoria a dense, fine-grained blue-black to dark grayish-green basalt outcrops in the ridge bordering the city on the south. It is quarried near the head of Sixteenth Street. The structure is characterized by irregular vertical jointing and cross fractures, which split the rock near the surface into small fragments and blocks, but more massive rock may be obtained by deeper quarrying. At present this rock is for the most part crushed and screened to concrete sizes, but considerable quantities are used as rubble and dimension stone in foundations and retaining walls in Astoria. The basement walls of the high school building are of dimension stone from this quarry, and the main part of the building is constructed of concrete containing the basalt in the aggregate. The concrete is faced with white cement, which makes a striking contrast with the dark stone facing below. A large fireproof office building and other structures in Astoria are built of basalt concrete.

A greenish diabase is quarried at Miami, on Tillamook Bay, and in the Coos Bay region basalt outcrops on both sides of Coos River a short distance below the forks, where it can be conveniently obtained.

Several quarries are opened in basalt along Columbia River above the mouth of the Willamette, as at Warrendale, Hood River, Mosier, and The Dalles, and in other parts of the State the usefulness of the rock is equally well appreciated wherever the demand arises, as is shown by quarries at Klamath Falls, La Grande, and Baker City. In addition to the uses above noted paving blocks are made from basalt at certain quarries.

According to Collier, in the John Day region the Columbia River quarries have furnished basalt for a large store building at Heppner. The color of this basalt is not particularly pleasing, but otherwise the stone gives satisfaction. There is an abundance of basalt in this region suitable for roads and for concrete.

Light volcanic rocks.—There are no Survey data at hand concerning the relation of this type of rocks to the building trades in Oregon, but fortunately Parks has described the deposits at present of most importance, and the following notes are extracts and adaptations from his recent paper.[1]

Volcanic tuff, a rather unique building material which gives much promise, occurs over a wide area in eastern Oregon and is found also

[1] Parks, H. M., op. cit., pp. 37–40.

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in some parts of western Oregon. The body of this rock is made up of volcanic ash particles, through which are scattered darker fragments of volcanic glass, broken pieces of feldspar crystals, and occasional masses of pumice. These particles vary from the size of fine-grained sand to that of the gravel pebble. The tuffs are probably formed by the accumulation of ash and other volcanic materials, which were ejected from some prehistoric volcano of the explosive type. It is likely that in most instances the deposition took place in much the same manner as the recent accumulation of volcanic ash over large areas in Alaska during the eruption of Katmai Volcano. Whatever its exact origin this deposit of fragmental materials was later buried by lava flows and sedimentary rocks, which consolidated it into a firm rock. At times the lava particles which were explosively projected into the atmosphere by the eruption may have fallen into bodies of water where they would become sorted to some extent into layers of coarse and fine material.

Volcanic tuff has been quarried and used in many places in the John Day Valley and in Wallowa, Baker, and other eastern Oregon counties. Very similar rock is also found in two or three localities in Marion County. In different places it varies materially in color, texture, and general qualities. The tuffs are very light in weight, being only about two-thirds as heavy as ordinary sandstone. The color is usually light, which gives a pleasing appearance for many purposes from an architectural standpoint. They can be worked very easily, sawed or carved into all kinds of shapes, and possess sufficient compressive strength to meet safely any proper conditions that will be imposed upon them even in our largest public buildings. The use of tuff in many places has demonstrated the adaptability of the stone to the climate of eastern Oregon. It is considerably less costly than some of the harder building stones, such as granite, sandstone, and limestone. Since this type of building stone has been most largely developed and more generally used in Baker County, only that general region will be discussed.

The two quarries from which the bulk of the Baker County stone is obtained are about 13 miles southeast of the city of Baker, on the Oregon-Washington Railway, near the station of Pleasant Valley. One of these, known as the Ideal quarry, is less than half a mile north of the station, the other, the property of the Oregon Lava Stone Co., is about 1,000 feet south of the station. The rocks in the general region of Pleasant Valley are chiefly a series of lava flows, tuffs, and lake-bed deposits overlying the older greenstones. These rhyolitic flows and the deposition of the volcanic tuffs and lake sediments in this region seem to have taken place during about the same period. That is to say, volcanic eruptions of varying nature accompanied or succeeded each other, thus giving at times both solid and glassy rocks and also the loose-textured fragmental materials that are now consolidated into tuffs; while sediments were at the same time accumulating in the bottom of lakes that covered portions of that region. In very few of the quarries examined are any indications of bedding found. This shows that water probably had in most cases very little to do with the deposition of the rock strata. One exception to this rule is observed at the Ideal quarry, where the true lake beds are apparently overlain by volcanic tuff, which later also seems to show

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some bedding. These beds have a strike of N. 70° W. and a dip to N. 35°.

The Ideal quarry is opened on the south slope of the hill, the beds dipping directly against the slope. On account of this relation between the attitude of the beds and the slope of the land surface greater difficulties have to be met in quarrying, on account of the increasing overburden, than if the quarry could be located at a point where the dip and the surface slope are more nearly in the same direction. It seems probable that a more favorable site in this respect could be selected within a few hundred feet. The joints in this quarry are parallel to and at right angles to the bedding direction. More or less faulting and other evidences of movement since the rocks were consolidated are apparent in most exposures of the volcanic tuff and old lake bed deposits.

At the Oregon Lava Stone Co.'s quarry on the south side of the railroad the rocks are broken by a series of vertical joints and a second set of joint planes which are approximately parallel to the surface. These last occur much more plentifully and closer together within a few feet of the surface. The explanation seems to be that this series of shallow joints is entirely due to weathering agencies. Some of the joint planes are smooth curves instead of plane surfaces. No bedding whatever is evident in this quarry.

In both of the Pleasant Valley quarries stone can be gotten out in very large blocks, if desired, on account of the wide spacing between joints. Cubes as large as 8 feet in each dimension can be easily obtained. The rock in each of the quarries varies to some extent in different parts of the face, but is usually a light gray in color and for the most part quite fine grained in texture. In some parts of the exposures, and especially in the lighter gray stone, scattered irregular fragments of glass and pumice occur. Few of the glass fragments are over a quarter of an inch in diameter, but the inclusions of pumice are found at times to measure as much as an inch across. These larger fragments are often of a different color than the finer groundmass, sometimes lighter and sometimes darker. The glass particles are usually colored, sometimes black, while the pumice is more nearly the color of the groundmass.

According to tests made by the United States Bureau of Standards these tuffs have an absorption of something more than 25 per cent and an average crushing strength of nearly 2,000 pounds to the square inch, which last is amply sufficient for ordinary building purposes. It should be noted also that the strength of the volcanic tuff shows no deterioration from repeated freezing and thawing.

The available supply of volcanic tuff in Pleasant Valley area appears to be inexhaustible. The rock can be seen at the surface over an area of about 200 acres. The maximum depth is not known. but a thickness of over 100 feet can be observed in places. The amount of overburden encountered in quarrying will vary. In some places there is not more than 2 or 3 feet of waste rock, while in others as much as 10 or 15 feet of soil and weathered rock is present.

On the whole, volcanic tuff as a building stone has many features in its favor. Its conspicuous advantages are its light gray color, its light weight, and the ease with which it can be worked and handled. Because of its porosity and darker color when wet it has been questioned by some whether such stone can be used to advantage as

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a building material in a climate similar to that of the Willamette Valley where the winter rainfall is heavy. On drying, it of course resumes its original characteristic color. Whether its high porosity would be found objectionable in a climate so damp as this for several months of the year is a question which sufficient data are not at hand to answer definitely. Many common brick used in building walls everywhere are, however, fully as porous and as absorbent as the tests show this type of stone to be.

In his recent article on the geology and mineral resources of the John Day region Collier[1] gives data of value concerning the possibilities of rhyolite tuff as a building stone as follows:

> This region is well supplied with building stones of various kinds, among the most promising of which is some rhyolite tuff, a prominent member of the Rattlesnake formation. As has been noted, the Rattlesnake formation lies in an almost horizontal position in the syncline in the southern part of the field. The rhyolite stands out as the capping rock for a great many mesas and shows by this that it is capable of resisting the weather in a notable way. Although this rock is to be seen along the valley all of the way from the town of John Day to and beyond Antone, the rock is most accessible near the town of Mount Vernon, where it is approximately 25 feet thick, and where there are several quarries from which small amounts have been taken at various times. A rock very similar to this, and possibly the same, is to be found scattered over the Mascall formation in large bowlders. The rock has been used for building smokehouses, cellars, and chimneys from Canyon City to Antone, and it can be seen in some larger buildings in John Day and Canyon City. It is light colored, pleasing to the eye, and in a climate as dry as that of the John Day region, its porous nature is not a disadvantage. Whether it would resist the weather as well in the Willamette Valley is an open question, but it probably will be found to work as well as in the John Day Valley.
>
> The rock owes its origin to some violent volcanic eruption either in the Cascade Mountains or nearer at hand. The materials of which it is composed were thrown up into the air and settled over the land surface. While they are nearly all light pumiceous fragments that could be carried for some distance by the winds, there are some fragments of more dense glass, the pressure of which would seem to indicate that water had been instrumental in bringing them to their present position.

Light volcanic rocks were noted by Stafford and Washburne[2] as follows: In Crook County volcanic tuff occurs along Des Chutes River which can be hewn into shape with an ax and which is used for fireplaces and other light building purposes. North of Alca station, Douglas County, green volcanic tuff has been worked by the Southern Pacific Railroad for revetment, fills, etc. This tuff continues north about 8 miles to Cottage Grove, where it was quarried in Cemetery Hill and used in foundations. Here it has a mottled yellow color, due to oxidation, and is not very suitable for building purposes. At Canyon City, Grant County, a soft, white volcanic ash, easily worked, was largely quarried for rebuilding part of the city after a disastrous fire in 1898. The stone makes a handsome building material, but is rather porous and has no mineral cement, the particles being held together by interlocking and by a paste of fine mud. Rhyolitic lavas said to be good for building purposes are reported from La Grande. Washburne considers that volcanic tuff and volcanic ash, unless cemented thoroughly by some insoluble substance, make poor building stones because of their absorptive properties, which cause flaking during frosts and hasten decomposition at all times.

Slate.—According to the Survey records there are no active slate quarries in Oregon. Records are few concerning slate deposits,

[1] Collier, A. J., op. cit., pp. 41–42. [2] Oregon Univ. Bull., new ser., vol. 1, No. 4, pp. 106–110.

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consequently a note by Collier [1] is of interest here. In the John Day region, in the forks of Currant Creek, sec. 29, T. 8 S., R. 19 E.,[2] there is a large area of slate most of which lies west of the wagon road. This slate is noteworthy on account of having an almost perfect cleavage, a feature that is very desirable and not very common. The cleavage and quality of the rock appear suitable for roofing slate and warrant prospecting, but these conclusions are based on a rather hasty examination, due allowance being made for the fact that only the weathered outcrops could be examined.

Marble.—The occurrence of marble has been reported from Douglas, Jackson, Josephine, and Wallowa counties, Oreg., and quarries are now in operation in the last two counties. The marble in Douglas County occurs in several places about 8 miles, measured in an air line, east-southeast of Roseburg and belongs to limestone lentils (Whitsett limestone lentils of Diller) in the Cretaceous Myrtle formation. This marble is dense, rather fine grained limestone, variegated in color. Some is dove-colored, with white seams of calcite in the joint and fracture planes. Mottled gray shades are shown with white veins, while other portions are brecciated and show red and yellow shades with white and gray veins and areas. The quarry in this marble was abandoned many years ago. Some of the stone was used in the Douglas County courthouse at Roseburg, and some was used for monuments. Parts of the rock take a good polish, but, since different portions of the mass vary considerably in hardness, the rock is not easy to work. As shown by a monument about 20 years old the material does not weather well. The polished surface becomes rough and seams are opened.

A reference to marble in Jackson County is given by Diller [3] to the effect that marble is reported to occur near Rocky Point. A deposit of gray and white banded marble is reported to the writer to be situated about 15 miles west-southwest of Medford.

Deposits of marble occur in Josephine County about 24 miles south of Grants Pass. One deposit is near the head of Williams Creek, and another is about 15 miles farther west on Deer Creek. The stone of Williams Creek is in part limestone and in part coarse-grained variegated marble. The mass is lens-shaped, about 300 feet wide and more than 1,000 feet long, according to A. N. Winchell, who visited the deposit in 1913. The marble is in part a strikingly veined, black and white crystalline material, and there is also a light gray stone and some is nearly white. The stone takes a good polish and weathers as well as most marbles, to judge from tombstones in the Grants Pass cemetery. The quarry is so far from a railroad that it is worked only in a small way and intermittently for monument stock. Blocks are rolled down hill, then hauled about 6 miles to a cutting shop, and then about 20 miles to Grants Pass for finishing. The marble on Deer Creek is black and gray, veined with white calcite. It is not developed.

A study of a promising deposit of black marble about 5 miles southwest of Enterprise, Wallowa County, has recently been made by Parks, who has published a description of the material and its geologic

[1] Collier, A. J., op. cit., p. 42.
[2] Regarding the location Collier cites J. C. Merriam, Contributions to the geology of the John Day Basin: California Univ. Dept. Geology Bull., vol. 2, p. 280.
[3] Diller, J. S., A geological reconnaissance in northwestern Oregon: U. S. Geol. Survey Seventeenth Ann. Rept., pt. 1, p. 514, 1896.

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relations.[1] The marble outcrops about 2,000 feet above the level of Wallowa Valley and has been traced in an east-west direction, on the strike, more than 1,000 feet. The thickness of the bed is known to be more than 500 feet in some of the more favorable exposures. The individual beds vary in thickness from 2 to 6 feet, and are cut by joints 2 to 6 feet apart, but in the quarry at a depth of 16 feet from the surface blocks of 60 to 75 cubic feet can be obtained without difficulty. Intrusions of basic igneous rock cut the marble in places. The rock is dense and very fine grained, of a grayish-black color which becomes darker on polishing. Some beds are lighter colored, and some of the black stone contains here and there white spots of calcite which make a strong contrast in color. The lighter-colored beds might be quarried for building stone. The black material appears susceptible of a high polish.

Limestone and lime.—Limestone is found in all the counties which contain marble, since the marble beds are either dense limestones susceptible of a high polish, or else are metamorphosed phases of larger deposits of limestone. Lime is burned at most of the localities which produce limestone, but where the stone is not used for lime it is mostly crushed for concrete and road material. The stone near Roseburg is said to be excellent for lime. A chemical analysis of the black marble near Enterprise shows less than 5 per cent of impurity, and there are limekilns in operation both northwest and southeast of the town. About 4 miles southwest of Dallas, quarries have been opened in fine to coarse grained argillaceous limestone which varies in color from brownish green to dark grayish green. This stone has been used as monumental and also as building stone, the courthouse at Dallas having been constructed of it. An abundance of rock occurs here, and the thickness of the beds and the joint spacing is such that blocks of large size can be obtained. There is a possibility that the rock may be used for the manufacture of Portland cement at Oswego, by mixing with it a high-calcium limestone. Limestone deposits of considerable magnitude occur in Baker County, not far from Baker City, and also to the southeast in the vicinity of Huntington. Large limekilns are in operation at several points near the Oregon-Washington Railroad & Navigation Co. line. Grant and Union counties, also, in northeastern Oregon are reported to contain limestone deposits of considerable extent, and quarries have been opened at Prairie City and La Grande.

Sandstone.—The sandstones of Oregon that are at present of the greatest importance are chiefly in the Coast Range, and are of Tertiary age. These sandstones are quarried in several places for buildings, bridge piers, and for the construction of jetties. From the latitude of Portland southward deposits of sandstone are found in practically all the counties along the coast and in the Willamette, Umpqua, and Rogue River valleys, but south of the latitude of Eugene they are especially abundant. Near the coast the sandstone is generally a little softer than farther east.

In Washington County, 2½ miles west of Gaston, occurs a fine-grained sandstone, dark bluish gray when fresh, but lighter or greenish-gray when weathered. The stone is composed chiefly of quartz grains with some feldspar, muscovite, and olivine cemented by argillaceous material. Two quarry openings have been made here,

[1] Parks, H. M., op. cit., pp. 30-35.

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the upper of which shows a thickness of 25 feet and the lower 50 feet of sandstone. The stone is reported to work easily, but is of a rather somber color. It has been used in a number of public buildings, among them the courthouse at Hillsboro. In Lincoln County, near Pioneer post office or Morrison station, a massive bedded medium fine-grained light-gray sandstone occurs in large quantities and for many years prior to 1898 was worked on an important scale; the stone was shipped to San Francisco, where the Call Building and the Emporium were built of it. Many buildings in the Willamette Valley, including two structures of the Oregon Agricultural College at Corvallis, the city hall and other buildings in Salem, and bank buildings in Eugene and Woodburn, also contain this stone. This sandstone is composed chiefly of fine grains of quartz with a few particles of feldspar, biotite, and hornblende. The cement is chiefly argillaceous, with a little calcium carbonate. The rock has an even texture, is soft enough to work easily, but possesses ample strength for building purposes and shows no deterioration in the freezing and thawing test. Just west of Monroe, Benton County, occurs a fine-grained, even-textured, grayish-green sandstone, consisting chiefly of quartz grains with a few particles of feldspar, olivine, and flakes of muscovite and films of secondary calcite. About 6 feet of beds are exposed in quarry openings at this place, and apparently blocks having a maximum dimension of 3 feet are obtainable. This stone has been used in the steps and trimming of the courthouse at Corvallis. Near Albany a greenish-gray to yellow sandstone has been quarried. In the Coos Bay region soft sandstone is found in abundance. On Coos River, near Marshfield, a micaceous sandstone has been quarried for jetty work. Lane County has several sandstone-bearing formations. Near Eugene, blue, fine and even-grained fossiliferous sandstone, greenish-gray in color, has been extensively quarried for local use. This sandstone is reported to be obtainable in blocks up to 5 feet long. A compact sandstone suitable for foundations has been quarried on the south side of Siuslaw River near Point Terrace. This outcrop is on tidewater, which facilitates shipment of the stone. At Loraine gray sandstone has been quarried for fireplaces, foundations, etc. Other sandstone quarries have been opened in Lane County, at Fairmount, and near Forest Grove and Turner. In Douglas County are a number of sandstone quarries, both active and inactive. Two and one-half miles north of Drain there is a large quantity of yellow sandstone suitable for bridge piers. The most important sandstone locality in Douglas County is east of the Southern Pacific Railroad between Roseburg and Sutherlin.[1] Quarries have been opened about 4 miles southeast of Sutherlin in gray, medium-grained, firmly cemented sandstone belonging to the Umpqua formation. The rock lies in beds 12 inches to 16 feet thick, separated by seams of shale. The jointing facilitates quarrying and permits blocks 5 to 10 feet long to be quarried. The rock is reported to work well and to be limited in available quantity only by the practical limitations of clearing and stripping. This stone is rather hard and dense, and shows a crushing strength of about 9,000 pounds to the square inch. It is reported to have been used in several buildings

[1] Notes from personal communication from L. G. Hicks, Roseburg, Oreg., also description by H. M. Parks, op. cit., pp. 27-28.

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in Portland, including the Methodist Episcopal churches at Union Avenue and Multnomah Street, and Thirty-fifth and Yamhill Streets, a Congregational church at Thirty-second and Taylor Streets, a Presbyterian church at Fifty-fifth and Belmont Streets, and in the base course and steps of the Electric Building, also in a church in Albany and in a bank building in Sutherlin. Paving blocks from this sandstone have been laid in Russell Street, Portland. Other sandstones in this same area include a fine-grained, light-gray stone outcropping about 6 miles from Roseburg, and a medium-grained buff-gray sandstone about 4 miles north of Roseburg. These two deposits are but little developed.

In Jackson County, 5½ miles southwest of Medford, occurs a medium-grained bluish-gray to brown sandstone, composed largely of quartz grains with a few scales of black mica, and cemented in large part by calcium carbonate. This is a hard, massive sandstone, and appears to be a valuable stone although it has not been actively quarried for several years. Near Ayers station the Southern Pacific Railroad formerly operated a sandstone quarry.

Other sandstone deposits in Oregon that have attracted attention, but which are not at present being quarried, include a tawny yellow sandstone on the north side of Cape Blanco, Coos County, from which rock was formerly shipped to San Francisco; sandstone near Eagle Point and Gold Hill, Jackson County; sandstone near Scotts Mills, and Jefferson, Marion County; and sandstone near Bay City, Tillamook County. The sandstone from Jefferson is fine grained, dark gray in color, with calcareous cement, and is reported to be easily carved and to have been used for the Oregon stone in the Washington Monument at the National Capital.

Production.—The total production of stone in Oregon in 1913 was valued at the quarries at $357,498, as compared with $268,002 in 1912.

Directory.—Quarries of all kinds of rock quarried in Oregon are listed below by class of rock, county, and town (or post office):

Directory of stone quarries in Oregon.

GRANITE.

Baker County: 1. Haines.
Jackson County:
2. Ayers.
Jackson County—Continued.
3. Near Medford (2).
4. Near Ray Gold.

DARK VOLCANIC ROCK (BASALT, ETC.).

Baker County: 1. Baker (2).
Clatsop County: 2. Astoria (2).
Columbia County: 3. St. Helens.
Hood River County: 4. Hood River.
Klamath County: 5. Klamath Falls.
Lane County:
6. Cottage Grove.
7. Eugene.
8. Springfield.
Marion County: 9. Salem.
Multnomah County:
10. Portland (2).
11. Rocky Butte (2).
12. St. Johns.
13. Warrendale.
Tillamook County: 14. Tillamook Bay (Miami).
Union County: 15. Lagrande.
Wasco County:
16. The Dalles.
17. Mosier.
Washington County:
18. Cherry Grove.
19. Near Hillsboro.
Yamhill County:
20. Amity.
21. Carlton.
22. Dayton.
23. McMinnville.

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LIGHT VOLCANIC ROCK (TUFF, ETC.).

Baker County: 1. Pleasant Valley (2).

MARBLE.

Douglas County: 1. Near Roseburg.
Josephine County: 2. Near Williams (25 miles south of Grants Pass).
Wallowa County: 3. Enterprise (5 miles southwest of).

LIMESTONE.

Douglas County: 1. Near Roseburg.
Grant County: 2. Prairie City.
Lane County:
3. Cottage Grove.
4. Eugene (near).
Marion County: 5. Salem.
Polk County: 6. Dallas (4 miles southwest of).
Union County: 7. Lagrande.

LIMESTONE AND LIMEKILNS.

Baker County:
1. Durkee.
2. Lime.
3. Pleasant Valley.
Grant County: 4. Canyon City.
Jackson County:
5. Goldhill (2).
6. Jacksonville.
Josephine County: 7. Wilderville.
Wallowa County:
8. Enterprise (6 miles southeast of).
9. Lostine (2).

SANDSTONE.

Benton County: 1. Monroe.
Coos County: 2. Marshfield.
Douglas County:
3. Roseburg (4 miles north of).
4. Sutherlin (3) (4 miles southeast of).
Jackson County:
5. Ayers.
6. Geary.
Lane County: 7. Eugene.
Lincoln County: 8. Pioneer.
Washington County: 9. Gaston (2½ miles northwest of).

WASHINGTON.

By E. F. Burchard.

Large areas of basalt cover the southern two-thirds of Washington and extend westward nearly to Puget Sound. As in Oregon, there are within the basalt area some Tertiary sediments. The northern portion of the State is largely underlain by Paleozoic metamorphic rocks with important areas of intrusive rocks of post-Cambrian age, and the western portion of the State is underlain principally by sediments of Jurassic, Cretaceous, Tertiary, and Quaternary age. Granites available for quarry purposes are found mainly in the intrusive areas north of the middle of the State, east of Puget Sound, but also in the southeastern part, near Snake River; marbles and limestones in the areas of Paleozoic and metamorphosed rocks in northeastern Washington; basalts and tuffs in the volcanic areas; and sandstone and limestone in the sediments of the Puget Sound and Olympic mountain regions. The following discussion of the stone resources of Washington has been derived in part from the paper by Prof. Solon Shedd on the Building and Ornamental Stones of Washington, published in the Annual Report of the Washington Geological Survey for 1902, pages 32 to 147, and in part from field notes by the writer, and from a few references in United States Geological Survey Geologic Atlas folios of central Washington by G. O. Smith. The paper by

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Shedd contains tabulated data on chemical analyses and physical tests of many of the important granites, tuffs, marbles, and sandstones.

Granite.—Quarries of granitic rock are situated in King, Snohomish, Stevens, Spokane, and Whitman counties, Wash., although not all of them are active at present, and there are other counties which contain good granite for which there is no demand. The granite quarried in Washington is all of a light-gray color, and according to physical tests is slightly below the average in crushing strength, besides having a higher percentage of pore space and a higher ratio of absorption than many other granites. Nevertheless, these granites are all amply strong for any demands, and are otherwise durable and handsome. The largest granite quarrying center is at Index, Snohomish County. Here the rock is light-gray medium-grained hornblende-biotite granite. The mountains in this locality are largely of granite and the material adjacent to the railroad is in practically inexhaustible quantity, can be quarried economically in large blocks, and is a durable stone of pleasing appearance for structural work. It does not take a good polish, and is consequently not so suitable for work where polished stone is required. Careful selection is necessary in places if it is desired to obtain stone free from small black "knots" or segregations of dioritic composition, which are common to the granite in the vicinity of Index. Particles of iron pyrites are present in places, especially in the "knots." The crushing strength of this stone as shown by tests ranges from 13,900 pounds to 16,610 pounds to the square inch. The product of the quarries at Index is used largely in western Washington for dimension stone, trimming, sills, curbing, foundations, and for paving blocks.

In the vicinity of Spokane granite occurs in two areas, one about 9 miles north and a little west of the city near Little Spokane River, the other at Medical Lake and Silver Lake about 13 miles west of Spokane. The granite near Little Spokane River is of a light-gray color, of irregular, medium to coarse grain, and is composed principally of quartz, feldspar, and both biotite and muscovite. Large blocks are available here, and the granite is not difficult of access, but requires a haul of 10 miles to a railroad. This granite takes a good polish and is quarried intermittently for monumental purposes as well as for all kinds of work for which rough or dressed granite is suitable. Crushing strengths of 12,870 pounds and 15,800 pounds were shown by test. The granite at Medical Lake forms a low bluff on the west side of the lake where it has been exposed by erosion of basalt which once covered the area. This rock is medium coarse grained, light-gray stone, composed principally of quartz, feldspar, and biotite. Sheeting and jointing cut the rock into blocks 3 to 10 feet thick and 8 to 12 or 15 feet long. This granite takes a good polish and is used for both building and monumental work. Among the buildings constructed of it are the administration buildings of the State University at Seattle, the Agricultural College at Pullman, the Medical Lake Insane Asylum, the Fort Wright buildings, and the basement of the Lewiston, Idaho, post office.

The granite near Silver Lake is a light bluish-gray fine to medium grained rock. The stone is much jointed and fractured into irregularly sized and shaped blocks, but blocks 4 by 4 by 6 feet are easily obtained. The rock contains some dark "knots," but most of these can be avoided in procuring blocks for monuments, although, of course, the

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"knots" entail more or less waste. Although the material at present quarried is from near the suface, this granite is reported to be harder to work than many other granites. On account of this property and because it takes a good polish, it is used mainly for monuments. A wagon haul of about 1 mile to Medical Lake station is necessary. In southeastern Washington granite has been exposed at two places by Snake River where it has cut its canyon down through the basalt. One of these exposures is at Granite Point, about 2 miles above the mouth of Wawawai Canyon, 30 miles below Clarkston. Granite is exposed for about one-third of a mile along the river and rises to a maximum height of about 150 feet above the river. The stone is a light-gray, coarse-grained, biotite granite containing very little hornblende. The biotite occurs to a certain extent in layers and gives the granite a gneissoid appearance. The stone is reported to work well, to take a high polish, and to be suitable for buildings, curbing, bridge piers, and other heavy masonry. It was largely used in the construction of the customhouse at Portland, Oreg. At that time the stone had to be floated down Snake River to Riparia, but now a railroad passes the quarry and gives a better opportunity for shipping the stone. The second exposure in southeastern Washington is in Asotin County near the mouth of Grande Ronde River. Here the stone is darker gray and finer grained than that at Granite Point. It is reported to take a fine polish and to have been used for monumental purposes. At present, however, no regular quarry is maintained on account of the inaccessibility of the stone, since Snake River is seldom navigable above Asotin.

Dark volcanic rock (basalt, etc.).—The large areal extent of basalt in southern and southeastern Washington renders it available for local use more commonly than any other type of rock, and there are more than 20 basalt quarries scattered all the way from Puget Sound to Spokane, several being along Columbia River opposite areas where basalt is quarried also in Oregon. Heretofore the output of many of these basalt quarries was included with granite, but an attempt has been made in the present chapter to put these figures on a more logical basis. The basalt varies much in texture, from dense, fine-grained, columnar rock to coarse-grained, cellular material. The color is generally dark gray to black and not very attractive, yet some pleasing effects have been produced by the use of basalt as a building stone. Only a few quarries will be mentioned here, mainly for the purpose of illustrating the types of rock found, their occurrence, and uses. At Fisher, Clarke County, on Columbia River, a fine-grained, compact, gray stone is quarried, and large quantities have been used in jetties at the mouth of Columbia River and at Grays Harbor, and also for foundations and for bridge piers. Basalt has proved satisfactory for foundations and portions of the walls of certain buildings of the Washington Agricultural College at Pullman. Six miles west of North Yakima on the north side of Cowiche Creek a quarry has been opened at the top of the bluff in irregularly jointed dark-gray to black cellular andesite—designated as the Tieton andesite in United States Geological Survey geologic folio No. 86. The rock is somewhat porphyritic, containing numerous crystals of white feldspar. The quarry consists of a small irregular opening between 300 and 400 feet above the creek. Rough masses are blasted out and rolled down the hillside, at the base of which rough blocks, sills, etc., are cut and

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loaded on wagons. The material is not very hard, and splits irregularly, but can be trimmed fairly evenly. The Elks clubhouse, a handsome building at North Yakima, is built of rock of this type. A dark, finer grained rock is crushed for macadam at North Yakima. In 1910 the quarry and crusher were operated by the State with convict labor.

Dense, fine-grained, columnar, black basalt capping the bluffs about 3½ miles west of Spokane has been quarried to a considerable extent. The top 15 to 25 feet of the material is quarried by being pried loose or blasted out in blocks, which are then rolled down the bluff and at the base are broken into rubble or cut into paving blocks. The rock seems to be admirable for paving blocks, as it cuts easily into sound, even blocks about 4 by 5 by 9 inches, having good, sharp edges.

Light volcanic rocks (tuff, etc.).—Rocks of this class, most of which are composed of fragmental volcanic material, more or less consolidated, are widespread in Washington and have been demonstrated to be of considerably more value than has popularly been supposed, yet they have not been employed to any considerable extent for building purposes. According to Shedd an indurated dark-gray tuff of hornblende-pyroxene-andesite is quarried on the west side of Hoods Canal, about 2 miles northeast of Hoodsport, in the foothills of the Olympic Mountains. The material is stratified and has been mistaken for a sandstone. Crushing tests showed the stone to resist pressures of 10,300 pounds and 11,590 pounds to the square inch, which, while lower than that required to crush granite, is high for this type of rock. The ratio of absorption is low, and the effect of alternate freezing and thawing each day for 20 days was slight. The most significant results, however, were obtained from the fire and quenching test. Samples were heated gradually in a muffle furnace to temperatures of 800° F., 1,200° F., and 1,600° F., then plunged into cold water without apparent injury, except change of color to a brick red. Granites subjected to the same tests would be badly injured, if not completely destroyed. This deposit is extensive, easy of access, and is on a deep-water channel about 80 miles from Seattle. Other important areas of tuff are near Bossburg and China Bend of Columbia River, both in Stevens County. This rock is light gray, fine, indurated tuff of dacite material. The deposit is in layers varying in thickness, and like the stone near Hoodsport was formerly quarried as a sandstone. The crushing strengths of two samples of this rock were determined to be 7,730 pounds and 9,300 pounds to the square inch. Freezing and thawing affects this rock but little, and heating to 800° F. and cooling suddenly did not injure it perceptibly, but heating to temperatures of 1,200° F., and 1,600° F., and subsequent quenching affected this stone much more seriously than it did the rock near Hoodsport. About 1 mile north of North Yakima on a high ridge overlying dark basalt is a yellowish-gray tuff, probably water-laid and fairly well indurated, that is quarried for local building purposes. The rock might easily be mistaken for a sandstone. It is tough, but not very hard, and breaks with crumbling rather than sharp edges. No data are available concerning its service.

In Asotin County a peculiar deposit of basaltic tuff has come to the attention of both Mr. Loughlin and the writer. It is situated on the west side of Snake River valley about 2 miles north of Asotin. In this vicinity the rock is mainly of columnar and broken basalt and the deposit of tuff, which lies on the north side of a ravine cut in the

basalt, is of limited extent. The tuff is of medium and generally uniform grains of basaltic material, loosely cemented and consequently very soft, and is generally of a greenish-yellow to yellowish-brown color, but some is dark gray. In places the rock contains "bombs" of vesicular basalt. No bedding is shown in places, but in others there is distinct crossbedding. The strength of the rock is very low and weathered pieces both in the quarry and in buildings are very soft and friable, yet it has been used in the construction of the Methodist Episcopal and Catholic churches and in a few dwellings and stone walls in Lewiston and in the front of a one-story bank building in Asotin. Cracks have appeared in places in structures built of this stone in Lewiston, evidently due to overloading. Notwithstanding the softness of the stone tool marks are preserved after 7 to 10 years in the favorable climate of Lewiston.

Mr. Loughlin reports the occurrence of a similar but finer grained stone at Asotin and Captain John creeks that has been used in the Lewiston National Bank Building. The sills below large windows all have one or more transverse cracks across them. This stone is very soft, but of a pleasing brownish yellow color.

Russell [1] noted this stone in early geologic studies, and though considering it of doubtful value for exterior work states that it has decided advantages for interior walls, especially of buildings designed to be fireproof.

Marble.—Shedd [2] makes the following statement concerning the occurrence of marble in Washington:

> Marble is found in a number of places in Washington, but the principal deposits are in Stevens County. Marble, however, is found in the Snoqualmie Pass region of the Cascade Mountains, and to the north of there in some few places. The amount, however, so far as known is not very great. In Stevens County the deposits are quite numerous and in many cases very large. At the present time western Washington is not producing any marble and but very little is known to occur in that part of the State.

Detailed descriptions are given by Shedd of the properties of more than 20 companies that were prospecting and developing marble deposits in Stevens County prior to 1903. The localities at which promising prospects were opened are shown on the map (Pl. VII), but it must be borne in mind that few if any of these are producing quarries at the present time. Shedd's conclusions regarding the marble deposits of Stevens County are as follows: [3]

> The marbles of Washington occur principally in Stevens County. They are of various colors and range in texture from those that are very fine to those that are very coarse. The composition is quite variable, in some cases being almost pure calcium carbonate, in others being magnesium carbonate with only traces of calcium carbonate, while in still others mixtures of calcium and magnesium carbonate are found in which there is more or less serpentine. The samples of marble used in making the physical tests shown in this report were perhaps hardly fair samples on account of the fact that many of the quarries are not developed to any extent as yet and the samples were necessarily from material that would not be as solid as it would be when a greater depth is reached. The results, however, of the tests of crushing strength show that the Stevens County marbles compare very favorably, as far as strength is concerned, with the best marbles from other parts of the United States. The specific gravity of these marbles is above the average, being as high as 2.908 in the case of the "Diamond Black" from the quarry of the United States Marble Co. [near Valley]. This same material also had the highest crushing strength of any sample tested, being 31,710

[1] Russell, I. C., Geology and water resources of Nez Perce County, Idaho: U. S. Geol. Survey Water-Supply Paper 54, pt. 2, p. 122, 1901.
[2] Shedd, Solon, Building and ornamental stones of Washington: Washington Geol. Survey Ann. Rept. for 1902, p. 76, 1903.
[3] Shedd, Solon, op. cit., pp. 146–147.

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pounds to the square inch. The average specific gravity was about 2.75, which is about the same as that of the Georgia marbles. The porosity of the Washington marbles is low, being in all the samples tested, with the exception of two, less than 1 per cent.

In but very few cases have the marble deposits of Washington been developed to any very great extent, and in fact it has not been more than about a couple of years since active work was begun on most of the properties that are being worked at present [1902]. Since that time a very large number of marble claims have been staked and much of the material that has been located will never be of any value as marble. In some cases it is so hard that it will be too expensive to work it, in others the question of transportation will prevent the working of the deposits at a profit, while in other places the deposits are so badly broken and shattered that they will be of no value as marble for building or decorative material, except in a small way.

The general opinion seems to be that as depth is reached the seams that may occur on the surface will certainly disappear, and that no matter how badly the marble may be broken on the surface it will be solid when a comparatively short distance below the surface is reached. This disappearance of these seams, however, as has been already shown, is only an apparent one in most cases at least, unless a considerable depth has been reached, and may be only apparent even then.

There are, however, in Stevens County quite a number of very promising marble properties, both as regards the ordinary grades of marble as well as the more valuable decorative varieties.

At present most of the marble used for interior decoration in the modern buildings being erected in the Puget Sound cities is quarried at Tokeen, in southeastern Alaska. It is shipped in rough blocks to Tacoma, Wash., where it is prepared for market. Descriptions of the marble deposits in southeastern Alaska have recently been published by the Survey.[1]

Limestone and lime.—Important deposits of limestone are found in all the northern counties of Washington from the Idaho boundary to Puget Sound. The fact that certain of these deposits are on deep water greatly enhances their value, since these are the only large deposits of limestone along the Pacific coast of the United States so situated. The use of limestone as dimension stone for building purposes in Washington is probably very limited. Some limestone is crushed for use in concrete and macadam, and much is used in the manufacture of Portland cement, but by far the greater part of the output is converted into lime. The limestone used for Portland cement is restricted to low-magnesian stone, but limestone containing magnesia in any percentage may be used for making lime. Practically the only paper on the limestones of Washington is the much-quoted article by Landes,[2] which was reprinted in 1913 in Bulletin 522 of the United States Geological Survey. Both bulletins are now out of stock, therefore a brief résumé of the distribution of these limestone deposits will be given here. It should be borne in mind, however, that the discussion is from the viewpoint of the requirements of limestone for the manufacture of Portland cement, and that the deposits suitable for lime and macadam are still more widely distributed.

In San Juan County the deposits of most importance are at tidewater on San Juan and Orcas islands. The principal deposits on San Juan Island are at Roche Harbor, at which point the largest lime works on the northwest Pacific coast are located. The limestone is crystalline and metamorphic, and has been thought to be of pre-Cretaceous age. Adjacent to the limestone there are large deposits

[1] Burchard, Ernest F., Marble resources of Ketchikan and Wrangell districts, Alaska: U. S. Geol. Survey Bull. 542, pp. 52-77, 1913; Marble resources of Juneau, Skagway, and Sitka districts, Alaska: U. S. Geol. Survey Bull. 592, pp. 95-107, 1914.

[2] Landes, Henry, Cement resources of Washington: U. S. Geol. Survey Bull. 285, pp. 377-383, 1906.

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of glacial sediments, which contain extensive beds of clay interbedded with sand. Some of the clay beds are known to be at least 40 feet in thickness, and are uncommonly free from gritty ingredients. In case these clays are not siliceous enough for use in cement manufacture, there are deposits of slate near at hand which might be utilized. In Whatcom County, in the vicinity of Kendall, there are a number of deposits of limestone and clay which afford the proper material for cement manufacture. An important outcrop of this limestone occurs in the form of a vertical cliff at a point about 3 miles from Kendall. The limestone is entirely crystalline and is a part of an extensive metamorphic series which has been greatly folded and crushed. A few miles west of the limestone deposits and along the railroad track are beds of glacial clay. One of these beds was drilled to a depth of 50 feet. The limestone is nearly pure, running 97.5 to nearly 99 per cent calcium carbonate, and the clay is apparently of a favorable composition for cement manufacture. In Skagit County large deposits of limestone and clay occur on the east side of Baker River, about three-fourths of a mile from its junction with Skagit River. This point is 40 miles from the mouth of the Skagit, a stream which is navigable at nearly all times of the year. The Seattle & Northern division of the Great Northern Railway also passes through this locality. The limestone is crystalline and nearly pure white in color. It is part of an extensive metamorphic series of unknown age. Slate adjoins the limestone, and these two formations strike a little west of north, the ledge of limestone dipping to the southwest at an angle of about 55 degrees. The outcrop is traceable for 600 feet along the strike and shows a width of 207 feet across the beds. The clay lies in horizontal beds in contact with the limestone, and is formed by silt brought down by Baker and Skagit rivers. It is well stratified and finely assorted, and rests upon beds of gravel. It is light blue in color, and has an average depth of 165 feet. There is also considerable limestone near Mount Sauk, on Jackman Creek and Baker River. In Snohomish County limestone occurs at a number of places in the eastern half of the county, and has been quarried at a point 3 miles east of Granite Falls. This stone is crystalline and is a member of an extensive metamorphic series extending in a broad north-south belt. The associated rocks are chiefly slate and schists. This rock has been quarried for the manufacture of lime and for use in flux and in paper making. The metamorphic series of rocks occurring in Whatcom and Snohomish counties continues into King County. In the vicinity of Snoqualmie Pass and at several points along the line of the Great Northern Railway, especially in the region about Baring, outcrops of crystalline limestone have been found. King County is particularly favored with clays of excellent quality. These clays occur chiefly in connection with the coal measures at Renton, Taylor, and Kummer. In the northern part of Okanogan County crystalline limestone has been discovered at many points, associated with slate, metamorphic sandstone, and conglomerate. The largest limestone areas are to the west and northwest of Riverside, where there are conspicuous cliffs of this rock covering an area of several square miles. On the eastern slope of Palmer Mountain are several prominent outcrops of light-gray limestone only partly crystalline. In Ferry County the largest limestone area is in the form of a long, narrow belt extending north-south across the country, and lies at the western foot of the granite divide separating Columbia and Kettle rivers from the

streams to the west. This limestone is crystalline and associated with other metamorphic rocks, and near by clay and argillaceous limestone also occur, which might be utilized in cement manufacture. Stevens County contains large deposits of material necessary for cement manufacture. The rocks of the county are chiefly metamorphic in character, consisting mainly of limestone or marble, and slate and quartzite. The rocks have been greatly disturbed by folding as well as by intrusion of igneous rocks. The limestones are usually entirely crystalline, and in several places yield marble of excellent quality. The only evidence as to the age of the rocks has been noted near Springdale, where the semicrystalline limestone contains coral remains, which indicates that it is Paleozoic, probably of Carboniferous age. Many of the limestones in Stevens County are high in magnesia, and careful field work will be necessary in order to determine the location and extent of the high-calcium limestones.

Sandstone.—Sandstone deposits are found mainly in the western half of Washington and have been developed principally around Puget Sound and on the western and eastern slopes of the Cascades. Geologically these sandstones range from possibly as early as Carboniferous to late Tertiary. The oldest sandstones are on the east side of the Cascades in the northern part of the State, but there are no quarries in this area at present. Cretaceous sandstones occur on several islands in San Juan County, and Tertiary sandstones around the borders of Puget Sound and on the slopes of the Cascades. The Cretaceous sandstones are in many places coarse grained and range in color from gray to various shades of brown. The Tertiary sandstones are fine to coarse grained and vary in color from light gray to dark bluish and dark greenish shades. There are several large sandstone quarries in the State, among which are those at Chuckanut Bay, Whatcom County, Stuart Island and other islands of San Juan County, Wilkeson, Pierce County, and Tenino, Thurston County.

The sandstone at Chuckanut Bay is grayish blue to grayish green in color, inclining toward a dark rather than toward a light shade. The grain is fine and angular. Two grades of stone, according to fineness, are available. Analyses show that silica constitutes 90 per cent of the rock. The cement, which is mainly iron oxide, with a little alumina and magnesia and a trace of lime, holds the grains firmly. The beds that are quarried here are about 40 feet thick, rise with a dip of 55° to a height of more than 100 feet, and extend along the bay for several miles. Tests showed crushing strengths of 10,740 pounds and 11,070 pounds to the square inch, and the fire and quenching tests showed but little effect when heated to 800° F. and suddenly cooled. Freezing and thawing also had but little effect. The stone at Chuckanut Bay is well situated for shipment by rail or by water. It has been used in many Federal, county, and business buildings in the Puget Sound region, and for flagstone. The hardness and fine texture of the stone render it suitable for carved and ornamental work.

Sandstone has been quarried at several places around Reeds Harbor on Stuart Island. The stone varies from fine grained to a coarse conglomerate. The stone is dark colored and is composed of rounded quartz grains cemented by silica and iron oxide. One sample showed a crushing strength of 8,900 pounds to the square inch. Dark colored sandstone of medium grain has been quarried on Sucia Island, which is 3 miles north of East Sound. On Waldron Island a bluish hard sandstone has been quarried for paving blocks.

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Light gray medium-grained sandstone, belonging to the Puget group, of Eocene age, is quarried 1 to 1½ miles northeast of Wilkeson. This rock consists mostly of even, angular to subangular quartz grains, but it contains generally a little mica, and in places small flakes of carbonaceous matter and a few grains of feldspar. Analysis shows it to contain 98.05 per cent silica, 0.89 per cent iron oxide, 0.27 per cent alumina, 0.22 per cent lime, and 0.12 per cent magnesia. Crushing tests of samples from the upper layer showed strengths of 7,680 pounds and 7,160 pounds to the square inch, and samples from the lower layer broke at 9,180 pounds and 10,840 pounds. Freezing and thawing tests affected the rock slightly, as did the fire and quenching tests. The darker sandstones were altered to a reddish color by the heat, but the color of the stone near Wilkeson remained unchanged. The rock is used for buildings, railroad work, riprap, and for paving block. The rock splits and trims well for pavers. Although rather soft the stone is tough and is serviceable as a paving block on hilly streets because it does not wear smooth as do some harder rocks.

A light-gray fine-grained sandstone composed mostly of rounded quartz grains with small flakes of mica has been quarried at Fairfax, 6 miles south of Wilkeson. This stone has been used for foundations for coke ovens. A light-colored medium-grained, firmly cemented sandstone with small flakes of muscovite and in places small seams of carbonaceous matter occurs near Cumberland, about 24 miles east of Tacoma. This rock was quarried for building stone about 20 years ago.

At Tenino, Thurston County, are large quarries in a fine, angular grained sandstone that is bluish gray where unweathered and grayish brown to buff where weathered. The stone consists principally of quartz grains with a few flakes of mica held together firmly by ferruginous cement. The rock contains about 90 per cent of silica and is very similar in chemical composition to the stone at Chuckanut Bay. The beds are massive and lie horizontal, so that the quarries are in the form of pits 75 feet or more in depth below the railroad level. Joints are rare and blocks as large as can be handled may be obtained. This sandstone is quarried on a large scale by modern quarrying machinery and is sawed, cut, grooved, planed, and turned in shops at the quarries. The stone is easily cut and is susceptible of delicate carving, and hence is much used for exterior decoration. The crushing strength as shown by records of tests ranges from 5,750 pounds to 6,879 pounds to the square inch. The fire and quenching test affected the coherence of the samples along the edges, and the color of the stone was changed to a brick red by the heat. The post office at Seattle is reported to have been constructed of sandstone from Tenino, and the stone is reported to have been used in the State Capitol at Olympia, the Bailey Building at Seattle, the Calvary Presbyterian Church in San Francisco, and in many other public buildings in the coast cities.

In the description of the Mount Stuart quadrangle Smith[1] gives the following notes on sandstones available for structural purposes:

The sandstone of the Swank and Roslyn formations is fairly well adapted for construction work. The Swank sandstone is more thoroughly indurated than the Roslyn

[1] Smith, George Otis, U. S. Geol. Survey Geol. Atlas, Mount Stuart folio (No. 106), p. 10, 1904.

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sandstone, but the more massive beds occur in localities which are not accessible. Sandstone from the productive portion of the Roslyn formation has been used somewhat in building, but no quarries have been opened. The tuffaceous sandstone of the Ellensburg formation has been used in buildings in Ellensburg, being obtained from a quarry a few miles beyond the southeast corner of the Mount Stuart quadrangle. Usually this stone is too soft and friable for use as a building stone.

Production.—The total production of stone in Washington in 1913 was valued at the quarries at $1,399,475, as compared with $1,174,047 in 1912.

Directory.—Quarries of all kinds of rock quarried in Oregon are listed below by class of rock, county, and town (or post office):

Directory of stone quarries in Washington.

GRANITE.

King County:
1. Baring.
2. Franklin.
3. Snoqualmie.
4. Veazie.

Snohomish County:
5. Granite Falls.

Snohomish County—Continued.
6. Index (4).

Spokane County:
7. Medical Lake (2).
8. Spokane (3) (9 to 12 miles north of).

Whitman County: 9. Granite Point.

DARK VOLCANIC ROCK.

(Basalt, etc.).

Clarke County:
1. Camas.
2. Fisher.

Cowlitz County:
3. Kelso.
4. Olequa.
5. Stella.

King County: 6. Riverton.

Kitsap County: 7. Charleston.

Klickitat County:
8. Goldendale.
9. Klickitat.

Lewis County: 10. Meskill.

Pierce County:
11. Electron.
12. Puyallup.

Skagit County:
13. Deception Pass.
14. Fidalgo.

Spokane County:
15. Marshall.
16. Spokane.

Thurston County: 17. Gate.

Walla Walla County: 18. Dixie.

Whitman County:
19. Colfax.
20. Palouse.
21. Pullman.

Yakima County:
22. North Yakima (4) (6 miles northwest of).
23. Selah.

LIGHT VOLCANIC ROCK.

(Tuff, etc.).

Asotin County: 1. Asotin (2 miles north of).

Mason County: 2. Hoodsport (or Lilliwaup).

Yakima County: 3. North Yakima (1 mile north of).

Stevens County: 4. China Bend and Bossburg.

MARBLE.

Chelan County:
1. Chelan.
2. Leavenworth.

Lincoln County: 3. Miles.

Spokane County: 4. Milan (8 miles north-northwest of).

Stevens County:
5. Addy (8 miles northwest of).
6. Bluecreek.
7. Bossburg.
8. Chewelah (3 to 5 miles east of).
9. Chewelah (2 to 5 miles southwest of).

Stevens County—Continued.
10. Colville (4 miles east-southeast of).
11. Mill Creek (15 miles east-southeast of).
12. Echo (7 miles northeast of).
13. Greenway Mountain.
14. Marble (1 mile northeast of)
15. Ryan.
16. Valley (2 miles east of).
17. Valley (5 miles northwest of).

Whatcom County: 18. Maple Falls.

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LIMESTONE.

Chelan County: 1. Chelan.
Ferry County: 2. Keller.
Pend Oreille County: 3. Metaline.
Stevens County: 4. Northport.

LIMESTONE AND LIMEKILNS.

Chelan County:
1. Lakeside.
2. Wenatchee.
Ferry County: 3. Republic (2).
Okanogan County:
4. Cheesaw.
5. Okanogan.
San Juan County:
6. Deer Harbor (2).
7. East Sound.
8. Roche Harbor.
9. Friday Harbor.
10. Orcas.
Stevens County: 11. Evans.
Whatcom County: 12. Sumas.

SANDSTONE.

Ferry County: 1. Republic.
Kitsap County: 2. Waterman.
Pierce County: 3. Wilkeson (2).
San Juan County:
4. Eastsound.
5. Stuart Island (5 miles from Roche Harbor).
San Juan County—Continued.
6. Waldron Island (2).
Skagit County: 7. Sedro Woolley.
Thurston County: 8. Tenino (2).
Whatcom County: 9. Chuckanut.

SURVEY PUBLICATIONS ON BUILDING AND OTHER STONE, SLATE, AND ROAD METAL.

The following list comprises the more important publications on stone, slate, and road metal by the United States Geological Survey. These publications, except those to which a price is affixed, can be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. The annual volumes on Mineral Resources of the United States between 1882 and 1899 and for 1911, 1912, and 1913, contain besides the statistics of stone production discussions of available stone resources in various parts of the country. Many of the Survey's geologic folios also contain notes on stone resources that may be of local importance. A descriptive price list of folios may be obtained from the Survey.

MISCELLANEOUS PUBLICATIONS.

ALDEN, W. C., The stone industry in the vicinity of Chicago, Ill.: Bull. 213, pp. 357–360, 1903. 25c.

BAIN, H. F., Notes on Iowa building stones: Sixteenth Ann. Rept., pt. 4, pp. 500–503, 1895. $1.20.

BASTIN, E. S. (See Leighton, Henry, and Bastin, E. S.)

BURCHARD, E. F., Concrete materials produced in the Chicago district: Bull. 340, pp. 383–410, 1908. 30c.

——— Structural materials near Austin, Tex.: Bull. 430, pp. 292–316, 1910.

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——— Stone resources east of Mississippi River: Mineral Resources, 1911, pt. 2, pp. 782–834, 1912. $1.10.

——— Stone resources of Great Plains and Rocky Mountain States: Mineral Resources, 1912, pt. 2, pp. 734–818, 1913.

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——— Marble resources of Juneau, Skagway, and Sitka districts, Alaska: Bull. 592, pp. 95–107, 1914.

BUTTS, CHARLES, Variegated marbles southeast of Calera, Shelby County, Ala.: Bull. 470, pp. 237–239, 1911.

CLAPP, F. G., Limestones of southwestern Pennsylvania: Bull. 249, 1905.

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DALE, T. N., The slate belt of eastern New York and western Vermont: Nineteenth Ann. Rept., pt. 3, pp. 153–200, 1899. $2.25.
——— The slate industry of Slatington, Pa., and Martinsburg, W. Va.: Bull. 213, pp. 361–364, 1903. 25c.
——— Notes on Arkansas roofing slates: Bull. 225, pp. 414–416, 1904. 35c.
——— Slate investigations during 1904: Bull. 260, pp. 486–488, 1905 (out of print).
——— Note on a new variety of Maine slate: Bull. 285, pp. 449–450, 1906. 60c.
——— Recent work on New England granites: Bull. 315, pp. 356–359, 1907. 50c.
——— The granites of Maine: Bull. 313, 202 pp., 1907. 35c.
——— The chief commercial granites of Massachusetts, New Hampshire, and Rhode Island: Bull. 354, 228 pp., 1908.
——— The granites of Vermont: Bull. 404, 138 pp., 1909.
——— Supplementary notes on the granites of New Hampshire: Bull. 430, pp. 346–372, 1910.
——— Supplementary notes on the commercial granites of Massachusetts: Bull. 470, pp. 240–290, 1911.
——— The commercial marbles of western Vermont: Bull. 521, 170 pp., 1912.
——— and GREGORY, H. E., The granites of Connecticut: Bull. 484, 137 pp., 1911.
——— and others, Slate deposits and slate industry of the United States: Bull. 275, 154 pp., 1906. 15c.
DARTON, N. H., Marble of White Pine County, Nev., near Gandy, Utah: Bull. 340, pp. 377–380, 1908. 30c.
——— Structural materials near Portland, Oreg., and Seattle and Tacoma, Wash.: Bull. 387, 36 pp., 1909.
DILLER, J. S., Limestone of the Redding district, California: Bull. 213, pp. 365, 1903.
ECKEL, E. C., Slate deposits of California and Utah: Bull. 225, pp. 417–422, 1904. 35c.
——— Cement materials and industry of the United States: Bull. 243, 395 pp., 1905. Edition exhausted. (Treats of limestone.)
ECKEL, E. C., BURCHARD, E. F., and others, Portland cement materials and industry of the United States: Bull. 522, 401 pp. (Treats of limestone.) 65c.
GARDNER, JAMES H., Oolitic limestone at Bowling Green and other places in Kentucky: Bull. 430, pp. 373–378, 1910.
HILLEBRAND, W. F., Chemical notes on the composition of the roofing slates of eastern New York and western Vermont: Nineteenth Ann. Rept., pt. 3, pp. 301–305, 1899. $2.25.
HOPKINS, T. C., The sandstones of western Indiana: Seventeenth Ann. Rept., pt. 3 (continued), pp. 780–787, 1896.
——— Brownstones of Pennsylvania: Eighteenth Ann. Rept., pt. 5 (continued), pp. 1025–1043, 1897.
——— and SIEBENTHAL, C. E., The Bedford oolitic limestone of Indiana: Eighteenth Ann. Rept., pt. 5 (continued), pp. 1050–1057, 1897.
HUMPHREY, R. L., The fire-resistive properties of various building materials: Bull. 370, 99 pp., 1909. 20c.
HUNTER, J. F., The Aberdeen granite quarry, near Gunnison, Colo.: Bull. 540, pp. 359–362, 1913.
KEITH, A., Tennessee marbles: Bull. 213, pp. 366–370, 1903. 25c.
LEIGHTON, HENRY, and BASTIN, E. S., Road materials of southern and eastern Maine: Bull. 33, Office of Public Roads, Department of Agriculture, 1908. (May be obtained from Department of Agriculture.)
LOUGHLIN, G. F., The gabbros and associated rocks at Preston, Conn.: Bull. 492, 158 pp., 1912.
PACK, ROBERT W., Ornamental marble near Barstow, Cal.: Bull. 540, pp. 363–368, 1913.
PAIGE, SIDNEY, Marble in Chiricahua Mountains, Arizona: Bull. 380, pp. 299–311, 1909. 40c.
PURDUE, A. H., The slates of Arkansas: Bull. 430, pp. 317–334, 1910.
RIES, H., The limestone quarries of eastern New York, western Vermont, Massachusetts, and Connecticut: Seventeenth Ann. Rept., pt. 3 (continued), pp. 795–811, 1896.
SHALER, N. S., Preliminary report on the geology of the common roads of the United States: Fifteenth Ann. Rept., pp. 259–306, 1895. $1.70.
——— The geology of the road-building stones of Massachusetts, with some consideration of similar materials from other parts of the United States: Sixteenth Ann. Rept., pt. 2, pp. 277–341, 1895. $1.25.
SIEBENTHAL, C. E., The Bedford oolitic limestone [Indiana]: Nineteenth Ann. Rept., pt. 6 (continued), pp. 292–296, 1898.
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UDDEN, JON A., Oolitic limestone industry at Bedford and Bloomington, Ind.: Bull. 430, pp. 335–345, 1910.
WATSON, T. L., Granites of the southeastern Atlantic States: Bull. 426, 282 pp., 1910.

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1882. Structural materials, pp. 450–464. 50c.
1883–84. Structural materials, pp. 662–670. 60c.
1885. Structural materials, by H. H. Sproull, pp. 396–413. 60c.
1886. Structural materials, by Wm. C. Day, pp. 517–566. 40c.
1887. Structural materials, by Wm. C. Day, pp. 503–534. 50c.
1888. Structural materials, by Wm. C. Day, pp. 516–557. 50c.
1889–90. Stone, by Wm. C. Day, pp. 373–440. 50c.
1891. Stone, by Wm. C. Day, pp. 456–473. 50c.
1892. Stone, by Wm. C. Day, pp. 704–711. 50c.
1893. Stone, by Wm. C. Day, pp. 543–602. 50c.
1894. Sixteenth Ann. Rept., U. S. Geol. Survey, pt. 4, Nonmetallic products.
Stone, by Wm. C. Day, pp. 436–510. $1.20.
1895. Seventeenth Ann. Rept., U. S. Geol. Survey, pt. 3 (continued), Nonmetallic products, except coal.
Stone, by Wm. C. Day, pp. 759–811.
1896. Eighteenth Ann. Rept., U. S. Geol. Survey, pt. 5 (continued), Nonmetallic products, except coal.
Stone, by Wm. C. Day, pp. 948–1068.
1897. Nineteenth Ann. Rept., U. S. Geol Survey, pt. 6 (continued), Nonmetallic products, except coal and coke.
Stone, by Wm. C. Day, pp. 205–309.
1898. Twentieth Ann. Rept., U. S. Geol. Survey, pt. 6 (continued), Nonmetallic products, except coal and coke. $1.00.
Stone, by Wm. C. Day, pp. 269–464.
1899. Twenty-first Ann. Rept., U. S. Geol. Survey, pt. 6 (continued), Nonmetallic products, except coal and coke.
Stone, pp. 333–360.
1900. Stone, pp. 661–692. 70c.
1901. Stone, pp. 641–666. 70c.
1902. Stone, pp. 665–701. 70c.
1903. Stone, pp. 755–789. 70c.
1904. Stone, pp. 801–841. 70c.
1905. Slate, by A. T. Coons, pp. 1011–1017; Stone, by A. T. Coons, pp. 1021–1067. $1.00.
1906. Slate, by A. T. Coons, pp. 1001–1005; Stone, by A. T. Coons, pp. 1007–1041.
1907. Slate, by A. T. Coons, pt. 2, pp. 557–562; Stone, by A. T. Coons, pt. 2, pp. 563–605. 50c.
1908. Slate, by A. T. Coons, with general note on the classification and characteristics of slate, by T. Nelson Dale, pt. 2, pp. 521–532; Stone, by A. T. Coons, pt. 2, pp. 533–579. 80c.
1909. Slate, by A. T. Coons, pt. 2, pp. 557–568; Stone, by E. F. Burchard, pt. 2, pp. 569–608.
1910. Slate, by A. T. Coons, pt. 2, pp. 627–641; Stone, by E. F. Burchard, pt. 2, pp. 643–682; Portland cement materials, by E. F. Burchard, pt. 2, pp. 488–535. (Discussion of limestones.)
1911. Slate, by A. T. Coons, pt. 2, pp. 723–739; Stone, by E. F. Burchard, pt. 2, pp. 741–834; Lime (Analyses of various limestones and limes), by E. F. Burchard, pt. 2, pp. 645–718. $1.10.
1912. Slate, by A. T. Coons, pt. 2, pp. 669–692; The commercial qualities of slates of the United States and their localities, by T. Nelson Dale, pt. 2, pp. 693–707; Stone, by E. F. Burchard, pt. 2, pp. 709–818.
1913. Slate, by A. T. Coons, pt. 2, pp. 71–84; Stone, by E. F. Burchard, pt. 2, pp. 1285–1410.

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II: 34

DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

THE PRODUCTION OF NATURAL GAS IN 1913

PREPARED UNDER THE SUPERVISION OF DAVID T. DAY
By B. HILL

Mineral Resources of the United States, Calendar Year 1913—Part II
(Pages 1411-1507)

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1914

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CONTENTS.

	Page.
Introduction	1411
Production and consumption	1412
Combined value of natural gas and petroleum	1419
Well record	1420
Acreage controlled by natural-gas companies	1421
Natural-gas industry, by States	1421
Pennsylvania	1421
New York	1424
West Virginia	1426
Kentucky	1429
Alabama	1430
Tennessee	1431
Ohio	1431
Indiana	1434
Illinois	1437
Kansas	1439
Missouri	1442
Oklahoma	1442
Louisiana	1446
Texas	1448
California	1450
Arkansas	1452
Colorado	1453
Iowa	1453
Michigan	1453
Montana	1454
North Dakota	1454
South Dakota	1454
Wyoming	1455
Imports	1455
Natural gas in foreign countries	1455
Canada	1455
Hungary	1456
Italy	1459
United Kingdom	1459
Composition of natural gas	1459
Gasoline from natural gas	1478
Production	1478
West Virginia	1480
Pennsylvania	1481
Ohio	1483
Oklahoma	1484
California	1484
Illinois	1485
Colorado	1486
New York	1486
Kansas	1486
Gasoline exports and imports	1486
Analyses of natural gas for gasoline content	1486
Carbon black	1488
Cities and towns supplied with natural gas	1499

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NATURAL GAS.

By B. Hill.

INTRODUCTION.

The year 1913 was the greatest in the history of the natural-gas industry in the United States, surpassing that of any previous year in both the quantity and the value of the gas produced. The returns show a decrease in the quantity and total value of the gas consumed in domestic use in 1913, as compared with 1912, but an increase in the average price per thousand cubic feet. This decrease in domestic consumption in 1913 was offset by the increase in the quantity and value of gas used for industrial purposes, for which there was at the same time an increase in the average price per thousand cubic feet. It will be seen from the reports of the last three years that the quantity and value of natural gas consumed for industrial purposes in the United States, as well as the average price, have been on the increase, and this greater consumption in 1913 indicates the general prosperity in the manufacturing industries of the country during that year.

One of the important features of the natural-gas industry in 1913 was the greater effort made to conserve the natural-gas resources of the country by saving the gas from oil wells by improved methods of drilling, by the installation of a greater number of plants for the extraction of gasoline from casing-head gas, and by the closing in of the "wild" well in Louisiana. Another important feature marking the progress of the natural-gas industry in 1913 was the completion of pipe lines and the successful introduction of gas into cities and towns of Indiana from the great gas fields of West Virginia; and, furthermore, the completion of the pipe line from the Midway field of California to southern California should be noted, and the successful introduction of natural gas into Los Angeles and surrounding cities and towns, the distance from the gas field to points of consumption being about 120 miles.

The total gas production in the United States in 1913 is estimated at 581,898,239,000 cubic feet, valued at $87,846,677, an average price of 15.10 cents per thousand cubic feet, as compared with a production of 562,203,452,000 cubic feet, valued at $84,563,957, an average price of 15.04 cents in 1912, this being an increase of 19,794,787,000 cubic feet in quantity and of $3,282,720 in value. Of this total product, about 32 per cent was utilized for domestic purposes, or 184,885,662,000 cubic feet, valued at $50,522,415, an average price of 27.33 cents per thousand cubic feet, and 68 per cent was utilized for industrial purposes, or 397,012,577,000 cubic feet, valued at $37,324,262, an average price of 9.4 cents per thousand cubic feet.

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PRODUCTION AND CONSUMPTION.

The following table gives, by States, the total value of the natural gas produced in the entire country from 1885 to 1913, inclusive:

Approximate value of natural gas produced in the United States, 1885–1913, by States.

State.	1885	1886	1887	1888	1889	1890	1891
Pennsylvania	$4,500,000	$9,000,000	$13,749,500	$19,282,375	$11,593,989	$9,551,025	$7,824,616
New York	196,000	210,000	333,000	332,500	530,026	552,000	280,000
Ohio	100,000	400,000	1,000,000	1,500,000	5,215,609	4,684,300	3,076,325
West Virginia	40,000	60,000	120,000	120,000	12,000	5,400	35,000
Illinois	1,200	4,000	.....	.....	10,615	6,000	6,000
Indiana	.....	300,000	600,000	1,320,000	2,075,702	2,302,500	3,942,500
Kansas	.....	6,000	.....	.....	15,873	12,000	5,500
Missouri	.....	.....	.....	.....	35,687	10,500	1,500
California	.....	.....	.....	.....	12,680	33,000	30,000
Kentucky and Tennessee	.....	.....	.....	.....	2,580	30,000	38,988
Texas and Alabama	.....	.....	.....	.....	1,728	.....	.....
Arkansas and Wyoming	.....	.....	.....	.....	375	.....	250
Utah	.....	.....	.....	.....	.....	.....	.....
Colorado	.....	.....	.....	.....	.....	.....	.....
South Dakota	.....	.....	.....	.....	.....	.....	.....
Indian Territory and Oklahoma	.....	.....	.....	.....	.....	.....	.....
Louisiana	.....	.....	.....	.....	.....	.....	.....
Other	20,000	32,000	15,000	75,000	1,600,175	1,606,000	250,000
Total	4,857,200	10,012,000	15,817,500	22,629,875	21,107,099	18,792,725	15,500,084

State.	1892	1893	1894	1895	1896	1897	1898
Pennsylvania	$7,376,281	$6,488,000	$6,279,000	$5,852,000	$5,528,610	$6,242,543	$6,806,742
New York	216,000	210,000	249,000	241,530	256,000	200,076	229,078
Ohio	2,136,000	1,510,000	1,276,100	1,255,700	1,172,400	1,171,777	1,488,308
West Virginia	70,500	123,000	395,000	100,000	640,000	912,528	1,334,023
Illinois	12,988	14,000	15,000	7,500	6,375	5,000	2,498
Indiana	4,716,000	5,718,000	5,437,000	5,203,200	5,043,635	5,009,208	5,060,269
Kansas	40,795	50,000	86,600	112,400	124,750	105,700	174,640
Missouri	3,775	2,100	4,500	3,500	1,500	500	145
California	55,000	62,000	60,350	55,000	55,682	50,000	65,337
Kentucky and Tennessee	43,175	68,500	89,200	98,700	99,000	90,000	103,133
Texas and Alabama	100	50	50	20	.....	.....	765
Arkansas and Wyoming	100	100	100	100	60	40	.....
Utah	.....	500	500	20,000	20,000	15,050	7,675
Colorado	.....	.....	12,000	7,000	4,500	4,000	3,300
South Dakota	.....	.....	.....	.....	.....	.....	.....
Indian Territory and Oklahoma	.....	.....	.....	.....	.....	.....	.....
Louisiana	.....	.....	.....	.....	.....	.....	.....
Other	200,000	100,000	50,000	50,000	50,000	20,000	20,000
Total	14,870,714	14,346,250	13,964,400	13,006,650	13,002,512	13,836,422	15,296,813

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Approximate value of natural gas produced in the United States, 1885–1913, by States—Continued.

State.	1899	1900	1901	1902	1903
Pennsylvania	$8,337,210	$10,215,412	$12,688,161	$14,352,183	$16,182,834
New York	294,593	335,367	293,232	346,471	493,686
Ohio	1,866,271	2,178,234	2,147,215	2,355,458	4,479,040
West Virginia	2,335,864	2,959,032	3,954,472	5,390,181	6,882,359
Illinois	2,067	1,700	1,825	1,844	3,310
Indiana	6,680,370	7,254,539	6,954,566	7,061,344	6,098,364
Kansas	332,592	356,900	659,173	824,431	1,123,849
Missouri	290	547	1,328	2,154	7,070
California	86,891	79,083	67,602	120,648	104,521
Texas	8,000	20,000	18,577	14,953	13,851
Alabama					
Kentucky	125,745	286,243	270,871	365,656	390,601
Tennessee					
Arkansas and Wyoming					2,460
Utah	1,480				
Colorado	3,500	1,800	1,800	1,900	14,140
Oklahoma				360	1,000
South Dakota		9,817	7,255	10,280	10,775
Total	20,074,873	23,698,674	27,066,077	30,867,863	35,807,860

State.	1904	1905	1906	1907	1908
Pennsylvania	$18,139,914	$19,197,336	$18,558,245	$18,844,156	$19,104,944
New York	522,575	623,251	672,795	766,157	959,280
Ohio	5,315,564	5,721,462	7,145,809	8,718,562	8,244,835
West Virginia	8,114,249	10,075,804	13,735,343	16,670,962	14,837,130
Illinois	4,745	7,223	87,211	143,577	446,077
Indiana	4,342,409	3,094,134	1,750,715	1,572,605	1,312,507
Kansas	1,517,643	2,261,836	4,010,986	6,198,583	7,691,587
Missouri	6,285	7,390	7,210	17,010	22,592
California	114,195	133,696	134,560	168,397	307,652
Texas	14,062	14,409	150,695	178,276	236,837
Alabama					
Louisiana		1,500			
Kentucky	322,404	237,290	287,501	380,176	424,271
Tennessee		300	300	300	350
Arkansas and Wyoming	6,515	21,135	34,500	126,582	164,930
Colorado	14,300	20,752	22,800		
Oklahoma	49,665	130,137	259,862	417,221	860,159
South Dakota	12,215	15,200	15,400	19,500	24,400
North Dakota				235	2,490
Oregon				100	250
Iowa					93
Total	38,496,760	41,562,855	46,873,932	54,222,399	54,640,374

State.	1909	1910	1911	1912	1913
Pennsylvania	$20,475,207	$21,057,211	$18,520,796	$18,539,672	$21,695,845
New York	1,222,666	1,678,720	1,418,767	2,343,379	2,425,633
Ohio	9,966,938	8,626,954	9,367,347	11,891,299	10,416,699
West Virginia	17,538,565	23,816,553	28,435,907	33,324,475	34,164,850
Illinois	644,401	613,642	687,726	616,467	574,015
Indiana	1,616,903	1,473,403	1,192,418	1,014,295	948,278
Kansas	8,293,846	7,755,367	4,854,534	4,336,635	3,288,394
Missouri	10,025	12,611	10,496	11,576	6,795
California	446,933	476,697	800,714	1,134,456	1,883,450
Texas	453,253	956,683	1,014,945	1,405,077	2,073,823
Alabama			858,145	1,747,379	2,119,948
Louisiana					
Kentucky	485,192	456,293	407,689	522,455	509,846
Tennessee	350	300	300	375	600
Arkansas and Wyoming	226,925	301,151	295,858	309,816	269,421
Oklahoma	1,806,193	3,490,704	6,731,770	7,334,599	7,436,389
South Dakota	16,164	31,999	16,984	30,412	31,166
North Dakota	3,025	7,010	5,738		
Oregon	50				
Iowa	50	40	70	120	120
Michigan	255	820	1,330	1,470	1,405
Total	63,206,941	70,756,158	74,621,534	84,563,957	87,846,677

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The following table shows the production and consumption of natural gas in 1912 and 1913, by States:

Quantity and value of natural gas produced and consumed in the United States in 1912 and 1913, by States.

1912.

State.	Produced.			Consumed.		
	Quantity (M cubic feet).	Cents per M cubic feet.	Value.	Quantity (M cubic feet).	Cents per M cubic feet.	Value.
West Virginia	239,006,682	13.94	$33,324,475	95,402,248	7.34	$7,001,331
Pennsylvania	112,149,855	16.53	18,539,672	173,656,003	15.25	26,486,302
Ohio	56,210,052	21.16	11,891,299	126,854,659	21.44	27,196,162
Oklahoma	73,799,319	10.04	7,406,528	41,549,403	7.58	3,149,376
Kansas	28,068,370	15.19	4,264,706	[a] 60,318,296	14.13	8,521,358
New York	8,625,979	27.17	2,343,379	16,927,598	28.75	4,866,321
Louisiana, Alabama	14,492,696	12.06	1,747,379	[b] 14,492,696	12.06	1,747,379
Texas	7,470,373	18.81	1,405,077	7,470,373	18.81	1,405,077
California	9,354,428	12.13	1,134,456	9,354,428	12.13	1,134,456
Indiana	3,618,077	28.03	1,014,295	3,618,077	28.03	1,014,295
Illinois	5,603,368	11.00	616,467	5,603,368	11.00	616,467
Kentucky	1,950,881	26.26	522,455	5,102,941	20.98	1,070,664
Arkansas, Colorado, Wyoming, South Dakota	1,742,379	17.78	309,816	1,742,379	17.78	309,816
North Dakota	54,320	55.99	30,412	54,320	55.99	30,412
Missouri	53,013	21.83	11,576	53,013	21.83	11,576
Michigan	1,920	76.56	1,470	1,920	76.56	1,470
Tennessee	1,500	25.00	375	1,500	25.00	375
Iowa	240	50.00	120	240	50.00	120
Total	562,203,452	15.04	84,563,957	562,203,452	15.04	84,563,957

1913.

West Virginia	245,453,985	13.92	$34,164,850	96,645,438	7.59	$7,333,956
Pennsylvania	118,860,269	18.25	21,695,845	177,463,230	16.18	28,709,565
Ohio	50,311,940	20.70	10,416,699	128,204,722	21.10	27,055,824
Oklahoma	75,017,668	9.91	7,436,389	51,249,294	7.30	3,740,961
Kansas	22,884,547	14.37	3,288,394	[a] 46,652,921	14.97	6,983,802
New York	8,515,257	28.50	2,425,633	16,738,545	29.20	4,888,412
Louisiana, Alabama	26,652,626	7.95	2,119,948	[b] 26,652,626	7.95	2,119,948
Texas	12,159,755	17.05	2,073,823	12,159,755	17.05	2,073,823
California	11,034,597	17.07	1,883,450	11,034,597	17.07	1,883,450
Indiana	[c] 3,220,885	29.44	948,278	3,220,885	29.44	948,278
Illinois	4,767,128	12.04	574,015	4,767,128	12.04	574,015
Kentucky	1,821,526	27.99	509,846	5,911,042	20.73	1,225,116
Arkansas, Colorado, Wyoming, South Dakota	1,106,374	24.35	269,421	1,106,374	24.35	269,421
North Dakota	66,492	46.87	31,166	66,492	46.87	31,166
Missouri	20,865	32.57	6,795	20,865	32.57	6,795
Michigan	1,805	77.84	1,405	1,805	77.84	1,405
Tennessee	2,400	25.00	600	2,400	25.00	600
Iowa	120	100.00	120	120	100.00	120
Total	581,898,239	15.10	87,846,677	581,898,239	15.10	87,846,677

[a] Includes gas piped from Kansas and consumed in Missouri; also gas piped from Oklahoma into Kansas and Missouri.
[b] Includes gas piped from Louisiana to Texas and from Louisiana to Arkansas.
[c] Includes gas piped into Indiana from West Virginia.

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In the following tables is given the distribution of natural gas consumed in 1912 and 1913, by States:

Distribution of natural gas consumed in the United States in 1912, by States.

State.	Number of producers.	Consumers.		Gas consumed.		
				Domestic.		
		Domestic.	Industrial.	Quantity (M cubic feet).	Cents per M cubic feet.	Value.
Ohio	2,031	641,724	4,414	67,150,744	28.92	$19,420,086
Pennsylvania	1,104	345,765	3,442	49,331,092	24.64	12,153,254
Kansas [a]	253	195,446	1,104	21,821,582	24.25	6,018,363
West Virginia [b]	406	94,273	1,953	16,180,778	18.11	2,930,628
New York	332	129,930	805	15,329,811	29.90	4,583,414
Oklahoma	242	47,017	1,651	6,500,062	19.83	1,288,894
Louisiana [c]	41	31,105	528	2,871,707	28.04	805,265
Alabama	9	152	4			
Texas	41	27,226	329	2,341,628	38.71	906,412
California	43	18,171	232	974,796	53.90	525,428
Kentucky	88	45,603	103	2,762,571	30.38	839,346
Indiana [d]	1,140	27,165	140	2,989,648	30.51	912,252
Illinois [e]	223	10,691	212	1,236,162	23.62	291,987
Arkansas	6	5,601	16			
Colorado	16	1,211	12	871,628	28.62	249,501
Wyoming	8	363	4			
South Dakota	32	403	3			
North Dakota	13	162	.....	44,420	56.31	25,012
Missouri	45	500	11	45,413	20.98	9,526
Michigan	21	14	2	1,020	100.00	1,020
Tennessee	7	3	.....	1,500	25.00	375
Iowa	5	3	.....	240	50.00	120
Total	6,106	1,622,528	14,965	193,454,902	26.34	50,960,883

State.	Gas consumed.					
	Industrial.			Total.		
	Quantity (M cubic feet).	Cents per M cubic feet.	Value.	Quantity (M cubic feet).	Cents per M cubic feet.	Value.
Ohio	59,703,915	13.02	$7,776,076	126,854,659	21.44	$27,196,162
Pennsylvania	124,324,911	11.53	14,333,048	173,656,003	15.25	26,486,302
Kansas [a]	35,496,704	7.05	2,503,495	60,318,286	14.13	8,521,858
West Virginia [b]	79,221,470	5.14	4,070,703	95,402,248	7.34	7,001,331
New York	1,597,787	17.74	283,407	16,927,598	28.75	4,866,821
Oklahoma	35,049,341	5.31	1,860,482	41,549,403	7.58	3,149,376
Louisiana [c]	11,620,989	8.11	942,114	14,492,696	12.06	1,747,379
Alabama						
Texas	5,128,745	9.72	498,665	7,470,373	18.81	1,405,077
California	8,379,632	7.27	609,028	9,354,428	12.13	1,134,456
Kentucky	2,340,370	9.88	231,318	5,102,941	20.98	1,070,664
Indiana [d]	628,429	16.24	102,043	3,618,077	28.03	1,014,295
Illinois [e]	4,367,206	7.43	324,480	5,603,368	11.00	616,467
Arkansas						
Colorado	870,751	6.93	60,315	1,742,379	17.78	309,816
Wyoming						
South Dakota						
North Dakota	9,900	54.55	5,400	54,320	55.99	30,412
Missouri	7,600	26.97	2,050	53,013	21.83	11,576
Michigan	900	50.00	450	1,920	76.56	1,470
Tennessee	.....	.....	.....	1,500	25.00	375
Iowa	.....	.....	.....	240	50.00	120
Total	368,748,650	9.11	33,603,074	562,203,452	15.04	84,563,957

[a] Includes the consumption of gas piped from Kansas to Missouri and from Oklahoma to Kansas and Missouri.
[b] Includes the consumption of gas piped from West Virginia to Maryland.
[c] Includes the consumption of gas piped to Texas from Louisiana and to Arkansas from Louisiana.
[d] Includes the consumption of gas piped from Indiana to Chicago, Ill.
[e] Includes the consumption of gas piped from Illinois to Vincennes, Ind.

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Distribution of natural gas consumed in the United States in 1913, by States.

State.	Number of producers.	Consumers.		Gas consumed.		
				Domestic.		
		Domestic.	Industrial.	Quantity (M cubic feet).	Cents per M cubic feet.	Value.
Pennsylvania	1,174	400,823	4,373	46,699,256	26.82	$12,524,475
Ohio	2,056	685,956	5,010	64,732,832	23.82	18,656,285
West Virginia [a]	451	101,234	1,834	15,524,092	19.32	2,999,005
Kansas [b]	305	195,131	950	20,550,852	24.22	4,977,137
New York	366	136,830	639	15,050,594	30.41	4,577,489
Oklahoma	347	49,308	1,793	7,089,196	17.85	1,256,518
Louisiana [c]	57	33,424	604	3,231,608	27.71	895,534
Alabama	7	340	3			
Texas	50	37,350	393	3,359,854	38.30	1,286,657
California	48	164,358	141	1,632,337	67.43	1,100,702
Kentucky	93	54,446	146	2,873,530	32.26	926,959
Indiana [d]	1,100	39,776	239	2,588,120	31.85	824,439
Illinois [e]	231	10,423	279	898,677	25.69	230,851
Arkansas	6	5,836	11	650,768	36.39	236,826
Colorado	15	1,212	9			
Wyoming	11	353	7			
South Dakota	32	397	5	31,922	61.16	19,523
North Dakota	13	62				
Missouri	52	342	7	17,899	33.61	6,015
Michigan	19	19	1	1,005	100.00	1,005
Tennessee	7	4		2,400	25.00	600
Iowa	5	3		120	100.00	120
Total	6,445	1,917,627	16,444	184,885,662	27.33	50,522,413

State.	Gas consumed.					
	Industrial.			Total.		
	Quantity (M cubic feet).	Cents per M cubic feet.	Value.	Quantity (M cubic feet).	Cents per M cubic feet.	Value.
Pennsylvania	130,763,974	12.38	$16,185,087	177,463,230	16.18	$28,709,562
Ohio	63,471,890	13.23	8,397,529	128,204,722	21.10	27,055,814
West Virginia [a]	81,120,746	5.34	4,334,951	96,645,438	7.59	7,333,956
Kansas [b]	26,102,069	7.69	2,006,665	46,652,921	14.97	6,983,802
New York	1,687,951	18.42	310,943	16,738,545	29.20	4,888,432
Oklahoma	44,210,096	5.62	2,484,163	51,249,294	7.30	3,740,981
Louisiana [c]	23,421,018	5.23	1,224,424	26,652,626	7.95	2,119,948
Alabama						
Texas	8,799,901	8.95	787,156	12,159,755	17.05	2,073,328
California	9,402,260	8.33	782,748	11,034,597	17.07	1,883,450
Kentucky	3,037,5.2	9.82	298,166	5,911,042	20.73	1,225,116
Indiana [d]	632,765	19.57	123,848	3,220,885	29.44	948,278
Illinois [e]	3,868,451	8.87	343,164	4,767,128	12.04	574,015
Arkansas	455,606	7.15	32,595	1,106,374	24.35	269,421
Colorado						
Wyoming						
South Dakota	34,570	33.68	11,643	66,492	46.87	31,166
North Dakota						
Missouri	2,966	26.30	780	20,965	32.57	6,795
Michigan	800	50.00	400	1,805	77.84	1,405
Tennessee				2,400	25.00	600
Iowa				120	100.00	120
Total	397,012,577	9.40	37,324,262	581,898,239	15.10	87,846,677

[a] Includes the consumption of gas piped from West Virginia to Maryland.
[b] Includes the consumption of gas piped from Kansas to Missouri and from Oklahoma to Kansas and Missouri.
[c] Includes the consumption of gas piped to Texas from Louisiana and to Arkansas from Louisiana.
[d] Includes the consumption of gas piped from Indiana to Chicago, Ill., and from West Virginia to Indiana.
[e] Includes the consumption of gas piped from Illinois to Vincennes, Ind.

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The following tables give the distribution of gas consumed for industrial purposes in 1912 and 1913, by States:

Distribution of gas consumed for industrial purposes in 1912, by States.

State.	Industrial consumers.			Gas consumed.		
				Manufacturing.		
	Manufacturing.	Other industrial (power).	Total.	Quantity (M cubic feet).	Cents per M cubic feet.	Value.
Pennsylvania	1,987	1,455	3,442	114,617,963	11.45	$13,127,440
Ohio	2,768	1,646	4,414	43,300,321	12.86	5,568,386
West Virginia	888	1,065	1,953	59,189,820	5.07	2,998,754
Kansas	959	145	1,104	32,353,405	6.94	2,246,186
Oklahoma	288	1,363	1,651	20,915,974	4.56	954,498
Louisiana, Alabama	150	382	532	2,992,216	8.38	250,803
California	.....	232	232	.....	.....	.....
Texas	(a)	329	329	(a)	.....	(a)
Illinois	26	186	212	948,415	10.00	95,088
New York	11	794	805	354,333	16.51	58,518
Kentucky	19	84	103	1,671,287	7.97	133,220
Indiana	20	120	140	223,547	18.19	40,675
Arkansas, Colorado, Wyoming, South Dakota	(a)	32	32	(a)	.....	(a)
North Dakota	.....	3	3	.....	.....	.....
Missouri	.....	11	11	.....	.....	.....
Michigan	.....	2	2	.....	.....	.....
Total	7,116	7,849	14,965	276,567,281	9.21	25,473,568

State.	Gas consumed.					
	Other industrial (power).			Total industrial.		
	Quantity (M cubic feet).	Cents per M cubic feet.	Value.	Quantity (M cubic feet).	Cents per M cubic feet.	Value.
Pennsylvania	9,706,948	12.42	$1,205,608	124,324,911	11.53	$14,333,048
Ohio	16,103,594	13.46	2,207,690	59,703,915	13.02	7,776,076
West Virginia	20,031,650	5.35	1,071,949	79,221,470	5.14	4,070,703
Kansas	3,143,299	8.19	257,309	35,496,704	7.05	2,503,495
Oklahoma	14,133,367	6.41	905,984	35,049,341	5.31	1,860,482
Louisiana, Alabama	8,628,773	8.01	691,311	11,620,989	8.11	942,114
California	8,379,632	7.27	609,028	8,379,632	7.27	609,028
Texas	5,123,745	9.72	498,665	5,123,745	9.72	498,665
Illinois	3,418,791	6.71	229,392	4,367,206	7.43	324,480
New York	1,243,454	18.09	224,889	1,597,787	17.74	283,407
Kentucky	669,083	14.66	98,098	2,340,370	9.88	231,318
Indiana	404,882	15.16	61,368	628,429	16.24	102,043
Arkansas, Colorado, Wyoming	870,751	6.93	60,315	870,751	6.95	60,315
South Dakota, North Dakota	9,900	54.55	5,400	9,900	54.55	5,400
Missouri	7,600	26.97	2,050	7,600	26.97	2,050
Michigan	900	50.00	450	900	50.00	450
Total	92,181,369	8.82	8,129,506	368,748,650	9.11	33,603,074

a Included in Other industrial.

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Distribution of gas consumed for industrial purposes in 1913, by States.

State.	Industrial consumers.			Gas consumed.		
				Manufacturing.		
	Manufacturing.	Other industrial (power).	Total.	Quantity (M cubic feet).	Cents per M cubic feet.	Value.
Pennsylvania	2,134	2,239	4,373	117,073,829	12.25	$14,338,226
Ohio	3,523	1,487	5,010	49,663,270	13.08	6,472,271
West Virginia	694	1,140	1,834	57,366,691	5.17	2,965,776
Oklahoma	325	1,468	1,793	22,947,560	4.72	1,083,154
Kansas	225	725	950	17,110,874	6.64	1,136,007
Louisiana, Alabama	121	486	607	3,144,472	8.04	252,834
Texas	(a)	393	393	(a)	.....	(a)
California	.....	141	141	.....	.....	.....
Illinois	22	257	279	643,813	13.83	89,057
New York	100	539	639	364,395	20.14	73,387
Kentucky	20	126	146	2,253,057	8.28	186,520
Indiana	85	154	239	263,079	24.47	64,375
Arkansas, Colorado, Wyoming	(a)	27	27	(a)	.....	(a)
South Dakota, North Dakota	.....	5	5	.....	.....	.....
Missouri	.....	7	7	.....	.....	.....
Michigan	.....	1	1	.....	.....	.....
Total	7,249	9,195	16,444	270,831,040	9.84	26,661,609

State.	Gas consumed.					
	Other industrial (power).			Total industrial.		
	Quantity (M cubic feet).	Cents per M cubic feet.	Value.	Quantity (M cubic feet).	Cents per M cubic feet.	Value.
Pennsylvania	13,690,145	13.49	$1,846,859	130,763,974	12.38	$16,185,087
Ohio	13,808,620	13.94	1,925,258	63,471,890	13.23	8,397,529
West Virginia	23,754,055	5.76	1,369,175	81,120,746	5.34	4,334,951
Oklahoma	21,262,538	6.59	1,401,009	44,210,098	5.62	2,484,163
Kansas	8,991,195	9.68	870,658	26,102,069	7.69	2,006,665
Louisiana, Alabama	20,276,546	4.79	971,590	23,421,018	5.28	1,224,424
Texas	8,799,901	8.95	787,156	8,799,901	8.95	787,156
California	9,402,260	8.33	782,748	9,402,260	8.33	782,748
Illinois	3,224,638	7.88	254,107	3,868,451	8.87	343,164
New York	1,323,556	17.95	237,556	1,687,951	18.42	310,943
Kentucky	784,455	14.23	111,646	3,037,512	9.82	298,166
Indiana	369,686	16.09	59,473	632,765	19.57	123,848
Arkansas, Colorado, Wyoming	455,606	7.15	32,595	455,606	7.15	32,595
South Dakota, North Dakota	34,570	33.68	11,643	34,570	33.68	11,643
Missouri	2,966	26.30	780	2,966	26.30	780
Michigan	800	50.00	400	800	50.00	400
Total	126,181,537	8.45	10,662,653	397,012,577	9.40	37,324,262

a Included in Other industrial.

The following table gives the value of natural gas consumed in the United States from 1908 to 1913, inclusive, by States:

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Value of natural gas consumed in the United States, 1908–1913, by States.

State.	1908	1909	1910	1911	1912	1913
Pennsylvania	$20,678,161	$21,639,102	$23,934,691	$23,940,001	$26,486,302	$28,709,565
Ohio	15,166,434	18,884,312	21,210,965	22,792,270	27,196,162	27,055,824
West Virginia	[a] 4,020,282	[a] 5,183,054	[a] 5,617,910	[a] 6,240,152	[a] 7,001,331	[a] 7,333,956
Kansas	[b] 7,691,587	[b] 8,356,076	[b] 9,335,027	[b] 9,493,701	[b] 8,521,858	[b] 6,983,802
New York	3,281,312	3,286,523	3,963,872	4,276,324	4,866,821	4,888,412
Oklahoma	860,159	1,743,963	1,911,044	2,092,603	3,149,376	3,740,981
Indiana	[c] 1,312,507	[c] 1,616,903	[c] 1,473,403	[c] 1,192,418	[c] 1,014,295	[c] 948,278
Texas				1,014,945	1,405,077	2,073,823
Louisiana	236,837	453,253	956,683	[d] 858,145	[d] 1,747,379	[d] 2,119,948
Alabama						
Kentucky	424,271	695,577	908,293	901,759	1,070,664	1,225,116
California	307,652	446,933	476,697	800,714	1,134,456	1,883,450
Illinois	[e] 446,077	[e] 644,401	[e] 613,642	[e] 687,726	[e] 616,467	[e] 574,015
Arkansas						
Colorado	164,930	226,925	301,151	295,858	309,816	269,421
Wyoming						
Missouri	22,592	10,025	12,611	10,496	11,576	6,795
South Dakota	24,400	16,164	31,999	16,984	30,412	31,166
North Dakota	2,480	3,025	7,010	5,738		
Michigan		255	820	1,330	1,470	1,405
Tennessee	350	350	300	300	375	600
Iowa	93	50	40	70	120	120
Oregon	250	50				
Total	54,640,374	63,206,941	70,756,158	74,621,534	84,563,957	87,846,677

[a] Includes value of gas piped from West Virginia to Maryland.
[b] Includes value of gas piped from Kansas to Missouri in 1908 and 1909, and from Kansas and Oklahoma to Missouri in 1910, 1911, 1912, and 1913.
[c] A portion of this was consumed in Chicago, Ill.
[d] Includes value of gas piped from Louisiana to Texas and Arkansas.
[e] Includes value of gas produced in Illinois and consumed in Vincennes, Ind.

COMBINED VALUE OF NATURAL GAS AND PETROLEUM.

The following tables give the value of natural gas and of petroleum and their combined value in 1912 and 1913, by States, arranged in the order of the value of the combined production:

Value of the natural gas and petroleum produced in 1912 and 1913, and their combined value, by States.

1912.

State.	Value of natural gas.	Value of crude petroleum.	Value of natural gas and crude petroleum.
West Virginia	$33,324,475	$19,927,721	$53,252,196
Oklahoma	7,406,528	34,672,604	42,079,132
California	1,134,456	39,624,501	40,758,957
Pennsylvania	18,539,072	12,886,752	31,426,424
Illinois	616,467	24,332,605	24,949,072
Ohio	11,891,299	12,085,998	23,978,767
Michigan	1,470		
Texas	1,405,077	8,852,713	10,257,790
Louisiana	1,747,379	7,023,827	8,771,206
Alabama			
Kansas	4,264,706	1,095,698	5,360,404
New York	2,343,379	1,401,880	3,745,259
Indiana	1,014,295	885,975	1,900,270
Utah		798,470	1,307,947
Wyoming			
Colorado	309,816	199,661	
Arkansas			
Kentucky	522,455	424,842	947,297
South Dakota	30,412		30,412
North Dakota			
Missouri	11,576		11,576
Tennessee	375		375
Iowa	120		120
Total	84,563,957	164,213,247	248,777,204

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Value of the natural gas and petroleum produced in 1912 and 1913, and their combined value, by States—Continued.

1913.

State.	Value of natural gas.	Value of crude petroleum.	Value of natural gas and crude petroleum.
Oklahoma	$7,436,389	$59,581,948	$67,018,337
West Virginia	34,164,850	28,828,814	62,993,664
California	1,883,450	45,661,400	47,544,850
Pennsylvania	21,695,845	19,805,452	41,501,297
Illinois	574,015	30,971,910	31,545,925
Ohio	10,416,699	17,538,452	27,955,151
Texas	2,073,823	14,675,593	16,749,416
Louisiana	2,119,948	12,255,931	14,375,879
Alabama			
Kansas	3,288,394	2,248,283	5,536,677
New York	2,425,633	2,169,357	4,594,990
Indiana	948,278	1,279,226	2,227,504
Arkansas	269,421	174,779	1,681,432
Colorado		1,187,232	
Wyoming			
Kentucky	509,846	675,748	1,185,594
Missouri	6,795		
Michigan	1,405	67,263	75,463
New Mexico			
Alaska			
South Dakota	31,166		31,166
North Dakota			
Tennessee	600		600
Iowa	120		120
Total	87,846,677	237,121,388	324,968,065

WELL RECORD.

The following table gives the record of natural gas wells in 1913, by States:

Record of natural gas wells in 1913, by States.

State.	Productive Dec. 31, 1912.	Drilled in 1913.			Abandoned in 1913.	Productive Dec. 31, 1913.
		Gas.	Dry.	Total.		
Alabama	19		7	7	1	18
Arkansas	97	3	1	4	2	98
California	71	9	4	13	8	[a] 72
Colorado	8				3	5
Illinois	453	60	119	179	58	455
Indiana	2,547	69	24	93	246	2,370
Iowa	6					6
Kansas	2,106	506	253	759	315	2,397
Kentucky	267	23	7	30	20	270
Louisiana	155	53	24	77	18	190
Michigan	19				1	[a] 18
Missouri	70	6		6	16	60
Montana		1		1		1
New York	1,736	200	54	254	56	1,880
North Dakota	24				7	[a] 17
Ohio	5,163	408	235	643	358	5,213
Oklahoma	936	423	298	721	307	1,052
Pennsylvania	11,543	1,011	259	1,270	299	12,255
South Dakota	35	2		2	2	[b] 35
Tennessee	6	2		2		8
Texas	87	43	29	72	7	125
West Virginia	5,533	1,038	128	1,166	108	6,463
Wyoming	24	4		4		28
Total	30,905	3,861	1,442	5,303	1,832	32,934

[a] Includes some artesian wells from which gas is used. [b] Artesian wells from which gas is used.

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ACREAGE CONTROLLED BY NATURAL-GAS COMPANIES.

The following table shows the number of acres of land held by natural-gas companies in 1912 and 1913, and whether the acreage was owned in fee or leased:

Acreage controlled by natural-gas companies in 1912 and 1913, by States.

State.	1912				1913			
	In fee.	Leased.	Gas rights.	Total.	In fee.	Leased.	Gas rights.	Total.
Alabama	570	216,000	.....	216,570	70	170,200	.....	170,270
Arkansas	600	20,059	.....	20,659	600	8,131	.....	8,731
California	2,434	7,690	.....	10,124	3,160	1,774	4,960	9,894
Colorado	.....	195	.....	195	1,080	35	.....	1,115
Illinois	3,568	165,337	17,342	186,247	1,687	174,766	2,032	178,485
Indiana	120,020	173,979	8,692	302,691	117,141	177,436	1,758	296,335
Kansas	25,405	366,475	17,870	409,750	32,217	406,046	13,945	452,208
Kentucky	2,970	113,947	.....	116,917	3,348	141,840	636	145,824
Louisiana	15,625	301,664	.....	317,289	19,896	343,871	4,414	368,181
Missouri	4,077	1,660	.....	5,737	1,403	.....	.....	1,403
New York	10,689	490,506	1,205	502,400	14,220	447,112	74,212	535,544
Ohio	14,834	1,711,552	29,781	1,756,167	20,026	1,393,073	102,463	1,515,562
Oklahoma	7,047	1,058,144	95,857	1,161,048	18,943	1,242,701	149,834	1,411,478
Pennsylvania	115,242	1,675,116	397,030	2,187,388	146,472	1,684,925	380,043	2,211,440
Tennessee	500	.....	.....	500	500	.....	.....	500
Texas	7,660	153,919	6,389	167,948	14,857	508,776	16,910	540,543
West Virginia	124,880	2,202,642	691,794	3,019,316	111,712	2,521,253	522,786	3,155,751
Wyoming	2,968	3,970	.....	6,938	2,328	16,368	.....	18,696
Total	459,089	8,682,855	1,265,940	10,407,884	509,660	9,238,307	1,273,993	11,021,960

NATURAL-GAS INDUSTRY, BY STATES.

PENNSYLVANIA.

The production of natural gas in Pennsylvania in 1913 was the largest ever recorded, amounting to 118,860,269,000 cubic feet, valued at $21,695,845, as compared with 112,149,855,000 cubic feet, valued at $18,539,672, in 1912, an increase of 6,710,414,000 cubic feet in quantity and of $3,156,173 in value.

The reports show unusual activity in the gas fields of the State in 1913, there having been a total of 1,011 productive gas wells and 259 dry holes completed. Some wells equal to those drilled in the early days of the natural-gas industry in this State were completed in 1913. In Allegheny County, where gas was piped and used for manufacturing in the Pittsburgh district as early as 1875, one well was drilled in 1913 which, at a depth of 2,300 feet, had an initial rock pressure of from 800 to 1,000 pounds; another, at a depth of 1,694 feet, had 645 pounds pressure, and two others, at a depth of 2,120 feet, had 400 pounds pressure. Throughout all the gas-producing fields of the State large quantities of gas are purchased at wells from producers by the large gas-distributing companies for distribution to consumers. In Clarion, Forest, Elk, and Jefferson counties are many gas wells ranging from 300 to 700 or 800 pounds in pressure. A new field of some importance was developed in 1913 in Elk County, where, at a depth of from 2,450 to 3,000 feet, about 11 gas wells, with a rock pressure of from 500 to 980 pounds, were drilled. A small gas field

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was also discovered in Indiana County, where a few wells of 600 pounds pressure were drilled at a depth of 1,646 feet; no gas has been sold from these wells. Throughout the counties of Butler, McKean, Warren, Venango, and Potter large quantities of gas are produced from the oil wells, which is used for both domestic and industrial purposes and add largely to the supply of this State. The gas from these wells is also rich in gasoline, and several plants for the extraction of gasoline from the gas have been installed, an account of which industry appears in another part of this report.

The State of Pennsylvania again takes the lead in both quantity and value of gas consumed in the United States in 1913. In 1912 Ohio led in the value of gas consumed, Pennsylvania taking first place in the quantity of gas consumed. The total gas consumption in Pennsylvania aggregated 177,463,230,000 cubic feet in 1913, valued at $28,709,565, an average of 16.18 cents per thousand cubic feet, as compared with 173,656,003,000 cubic feet in 1912, valued at $26,486,302, an average of 15.25 cents per thousand cubic feet, a gain of 3,807,227,000 cubic feet in quantity and of $2,223,263 in value.

The reports show that of this enormous consumption nearly three-fourths the quantity and more than half the value was for gas supplied for industrial use, which amounted to 130,763,974,000 cubic feet, valued at $16,185,087, an average of 12.38 cents per thousand cubic feet, as compared with 124,324,911,000 cubic feet, valued at $14,333,048, an average of 11.53 cents per thousand cubic feet, in 1912, an increase of 6,439,063,000 cubic feet in quantity and of $1,852,039 in value. Reference to the table showing the distribution of gas consumed in 1913 for industrial purposes, by States, shows that 117,073,829,000 cubic feet, valued at $14,338,228, or nearly 90 per cent, was supplied for manufacturing in this State. The excellence of natural gas as a fuel in all branches of the iron, steel, and glass industries was demonstrated years ago in the Pittsburgh district, the center of the manufacturing industry of western Pennsylvania, and the demand for it continues, notwithstanding the fact that this district has at its very doors fields of excellent coal sufficient for all purposes.

The consumption of natural gas in Pennsylvania in 1913 for domestic purposes was 46,699,256,000 cubic feet, valued at $12,524,478, or 26.82 cents per thousand cubic feet, as compared with 49,331,092,000 cubic feet, valued at $12,153,254, in 1912, an average of 24.64 cents per thousand cubic feet, a decrease in quantity but an increase in value of gas consumed, the average price per thousand cubic feet having advanced 2.18 cents.

As has been stated in previous reports, considerable quantities of the gas consumed in Pennsylvania is piped into the State from West Virginia. On the other hand, large supplies of gas are piped from the Pennsylvania gas fields to New York, Ohio, and West Virginia. The quantity of gas piped to New York alone amounted in 1913 to 8,223,288,000 cubic feet. The difference between the production and the consumption of natural gas (plus exports) in Pennsylvania shows the quantity and value of the gas piped into this State from West Virginia, which, in 1913, approximated 58,602,961,000 cubic feet, valued at

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$7,013,720, as compared with 61,506,148,000 cubic feet, valued at $7,946,630, in 1912, a decrease of 2,903,187,000 cubic feet in the quantity of gas imported. The values represent the price received for the gas at the point of consumption. These figures show that the quantity of gas imported into Pennsylvania from West Virginia in 1913 was almost equal to one-half of the gas produced in the State of Pennsylvania in 1913.

The number of productive gas wells in Pennsylvania at the close of 1913 was 12,255, of which 1,011 were drilled in that year. The number of gas wells abandoned in 1913 was 299.

In the following table is given a record of the natural-gas industry in Pennsylvania from 1897 to 1913, inclusive:

Record of the natural-gas industry in Pennsylvania, 1897–1913.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	176	$6,242,543	[a] 201,059	1,124	$5,392,661	314	96	2,467
1898	232	6,806,742	[a] 213,410	1,021	6,064,477	373	74	2,840
1899	281	8,337,110	[a] 232,060	1,236	7,926,970	467	104	3,303
1900	266	10,215,412	[a] 229,730	1,296	9,812,615	513	142	3,776
1901	296	12,688,161	[a] 326,912	1,743	11,785,996	660	143	4,436
1902	379	14,352,183	185,678	2,448	13,942,783	775	232	5,211
1903	414	16,182,334	214,432	2,834	16,060,196	699	126	5,910
1904	414	18,139,914	238,481	2,929	17,205,804	701	174	6,352
1905	351	19,197,336	257,416	2,845	19,237,218	765	168	6,566
1906	309	18,558,345	273,184	3,307	21,085,077	603	153	7,300
1907	344	18,844,156	295,115	3,812	22,917,547	769	180	8,051
1908	[b] 572	19,104,944	307,585	4,577	20,678,161	571	147	[c] 8,831
1909	[b] 777	20,475,307	294,781	5,377	21,639,102	756	166	[c] 9,499
1910	[b] 819	21,057,211	321,430	4,102	23,934,691	857	161	[c] 10,337
1911	[b] 1,067	18,520,796	330,537	4,597	23,940,001	832	224	[c] 10,885
1912	[b] 1,104	18,539,672	345,765	3,442	26,486,302	993	219	[c] 11,543
1913	[b] 1,174	21,695,845	400,823	4,373	28,709,565	1,011	259	[c] 12,255

[a] Number of fires supplied.

[b] Includes 216 producers having shallow wells in Erie County for their own domestic consumption in 1908, 311 producers in 1909, 345 producers in 1910, 399 in 1911, and 401 in 1912 and 1913.

[c] Includes 350 shallow wells in Erie County in 1908, 429 in 1909, 429 in 1910, 476 in 1911, and 492 in 1912 and 1913.

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In the following table are given the depth and gas pressure of wells in Pennsylvania from 1909 to 1913, inclusive, by counties:

Depth and gas pressure of wells in Pennsylvania, 1909–1913, by counties.

County.	Depth, in feet.	Pressure, in pounds.				
		1909	1910	1911	1912	1913
Allegheny	900–3,265	10–600	10–600	10– 800	10– 500	15–a1,000
Armstrong	702–3,450	25–900	3–800	3– 435	5– 900	1– 500
Beaver	700–2,000	4–600	4– 75	.....	30– 70	30– 510
Butler	700–3,384	30–600	6–700	4– 800	2– 700	4– 850
Clarion	600–3,000	8–800	25–900	5– 900	1– 900	2– 800
Elk	500–3,200	50–990	50–990	40– 900	60– 840	50– a980
Crawford	550–1,200	1– 85	0– 85	0– 100	2– 100	10– 50
Erie	300–1,600					
Fayette	1,750–2,772	100–700	100–650	40– 600	35– 700	35– 700
Cambria	2,350–2,500					
Forest	700–2,900	15–145	10–850	6– 150	5– 800	17– 700
Greene	680–3,600	50–500	40–400	40– 900	60– 575	39– 750
Indiana	1,100–1,646	.....	.....	.....	.....	600
Jefferson	700–3,360	10–635	100–700	60–1,200	90–1,000	100– 900
McKean	750–3,000	30–600	6–600	5– 850	1– 950	3– 800
Mercer	700–1,500	40	.....	160– 250	190	51– 300
Lawrence						
Potter	750–2,200	60–500	50–300	35– 500	10– 360	20– 600
Tioga	700–1,400	250	300	13– 350	.....	.....
Venango	350–2,110	20–250	10– 85	10– 500	15– 200	10– 200
Warren	500–3,290	20– 50	10–190	3– 200	10– 350	5– 200
Washington	606–3,304	12–500	5–800	5– 600	5– 550	5– 400
Westmoreland	1,675–3,300	50–180	10– 25	60– 250	15– 20	6–a1,000

a New well.

NEW YORK.

There has been little change in the natural-gas situation in New York since the report for 1912. The quantity of gas produced in 1913 is estimated at 8,515,257,000 cubic feet, as compared with 8,625,979,000 cubic feet in 1912, a decrease of 110,722,000 cubic feet. On the other hand, the value of the gas produced increased from $2,343,379 in 1912 to $2,425,633 in 1913, which exceeded that of any previous year and was $82,254 greater than that of 1912.

Considerable development work was undertaken in New York in 1913 and some very good gas wells were completed. Three wells with a pressure of about 500 pounds were completed in Genesee County. One well, with about 300 pounds pressure, was drilled in Orleans County, but it has been closed in. Erie County continues to furnish considerable gas from wells located in the vicinity of Orchard Park and Hamburg. Wells in Allegany and Cattaraugus counties also added considerable gas to the supply of the State. Conditions in other counties of the State show little change as compared with 1912, except slightly decreasing pressure.

As has already been stated in previous reports, New York imports considerable gas from Pennsylvania. During the year 1913 the total quantity of gas piped into this State was estimated at 8,223,288,000 cubic feet, a quantity almost equal to the total production. The quantity of gas consumed in New York declined from 16,927,598,000 cubic feet in 1912 to 16,738,545,000 cubic feet in 1913, while the total value increased from $4,866,821 in 1912 to $4,888,412 in 1913, a value greater than that of any preceding year. The average price

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of gas per thousand cubic feet advanced from 28.75 cents in 1912 to 29.20 cents in 1913.

Reference to the table of distribution of gas by States shows that the greater portion of the gas consumed in New York is used for domestic purposes, the quantity so used in 1913 being 15,050,594,000 cubic feet, valued at $4,577,469, an average of 30.41 cents per thousand cubic feet, while the quantity so used for industrial purposes was 1,687,951,000 cubic feet, valued at $310,943, an average of 18.42 cents per thousand cubic feet. The larger proportion of the gas consumed in this State for industrial purposes is used for the generation of power in gas engines and under boilers, a small quantity only being consumed for manufacturing. It is estimated that the consumption of gas for power in 1913 amounted to 1,323,556,000 cubic feet, valued at $237,556, and for manufacturing to 364,395,000 cubic feet, valued at $73,387.

The number of domestic consumers supplied in New York increased from 129,930 in 1912 to 136,830 in 1913, whereas the number of industrial consumers decreased from 805 to 639.

The number of productive gas wells in this State at the close of 1913 was 1,880, of which 200 were completed during the year. The number of dry holes drilled in 1913 was 54, and 56 gas wells were abandoned.

The estimated acreage held by gas companies in this State was 535,544 acres at the close of 1913, as compared with 502,400 acres at the close of 1912, an increase of 33,144 acres.

In the following table is given a record of the natural-gas industry in New York from 1897 to 1913, inclusive:

Record of natural-gas industry in New York, 1897–1913.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	41	$200,076	a 55,086	80	$874,617	33	7	359
1898	62	229,078	a 68,662	103	1,006,567	63	9	422
1899	84	294,593	a 76,544	121	1,230,007	36	7	447
1900	89	335,367	a 80,837	138	1,456,286	57	11	504
1901	114	293,232	a 95,161	98	1,694,925	53	14	557
1902	116	346,471	50,536	215	1,723,709	69	8	626
1903	144	493,686	57,935	208	1,944,667	75	11	700
1904	153	522,575	67,203	451	2,222,980	78	12	744
1905	148	623,251	67,848	447	2,434,894	89	17	839
1906	143	672,795	74,538	95	2,654,115	64	14	919
1907	208	766,157	83,905	155	3,098,833	61	13	1,049
1908	215	959,280	91,391	213	3,281,312	68	19	1,211
1909	282	1,222,666	92,958	570	3,286,923	86	18	1,340
1910	273	1,678,720	106,538	717	3,963,872	97	20	1,411
1911	302	1,418,767	116,314	208	4,276,924	167	53	1,531
1912	332	2,343,379	129,930	805	4,866,821	218	54	1,736
1913	366	2,425,633	136,830	639	4,888,412	200	54	1,880

a Number of fires supplied.

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In the following table are given the depth and gas pressure of wells in New York from 1909 to 1913, inclusive, by counties:

Depth and gas pressure of wells in New York, 1909–1913, by counties.

County.	Depth, in feet.	Pressure, in pounds.				
		1909	1910	1911	1912	1913
Allegany	600–1,900	6–300	10–300	15–150	7–300	7–250
Cattaraugus	400–2,800	8–250	10–90	1–120	0–700	0–500
Chautauqua	150–2,500	0–800	1–700	0–700	0–a 900	0–700
Erie	360–3,000	25–500	22–610	10–700	25–a 950	42–a 1,000
Niagara	550	150	.....	.....	.....	.....
Genesee	1,150–1,870	600	500	500	500	400
Livingston	345–2,000	15–450	10–380	100–400	200–525	200–400
Monroe	440 1,300	.....	.....	.....	50–400	160–400
Onondaga	1,000–3,000	.....	300–500	300–600	3–300	400–600
Ontario	114–2,300	60–480	5–400	60–440	55–450	1–450
Seneca	1,250–1,550					
Oswego	700–1,700	3–200	20–200	11–200	8–75	25–145
Schuyler	1,000–1,600	100–435	100–435	200–435	300–435	150–435
Yates	375–1,900					
Steuben	279–1,150	.....	50–100	.....	75–200	75–400
Wyoming	1,200–2,000	200	50	125	110–140	140–400

a New well.

WEST VIRGINIA.

The production of natural gas in West Virginia was greater in 1913 than in any previous year and more than twice the production of Pennsylvania in 1913. West Virginia has led all other States in the quantity of gas produced for the last five years. Her natural-gas resources are unrivaled. The gas production of this State in 1913 is estimated at 245,453,985,000 cubic feet, valued at $34,164,850, an average of 13.92 cents per thousand cubic feet, as compared with 239,006,682,000 cubic feet, valued at $33,324,475, an average of 13.94 cents per thousand cubic feet, in 1912, an increase of 6,447,303,000 cubic feet in quantity and of $840,375 in value.

The quantity of gas consumed in West Virginia in 1913 amounted to 96,645,438,000 cubic feet, valued at $7,333,956, an average price of 7.59 cents per thousand cubic feet, as compared with 95,402,248,000 cubic feet, valued at $7,001,331, an average price of 7.34 cents per thousand cubic feet, in 1912, an increase of 1,243,190,000 cubic feet and of $332,625. Of this total consumption in 1913 there was consumed for domestic purposes 15,524,692,000 cubic feet, valued at $2,999,005, and 81,120,746,000 cubic feet, valued at $4,334,951, was consumed for industrial purposes. Reference to the table of distribution of gas for industrial purposes in 1913, by States, shows that the greater part of the gas consumed in West Virginia was used for manufacturing, the average price received for this gas being 5.17 cents per thousand cubic feet. As much of the gas consumed in this State is not measured, the figures given must be considered approximate.

Many of the gas wells in West Virginia are closed in, some being conserved for future use, others being in lack of a market. There is no market within the State for the great volume of gas produced from the wells, and large quantities of gas are annually purchased at wells from the producers by the large gas-distributing companies and piped out of the State to supply consumers in cities and

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towns in Pennsylvania, Ohio, Kentucky, Maryland, and, during the last three months of 1913, Indiana. There is a notable difference between the quantity and the value of the gas produced and consumed in West Virginia and the quantity and value of the gas exported from the State to points distant, which in 1913 was 148,808,547,000 cubic feet, valued at $26,830,894, as compared with 143,604,434,000 cubic feet, valued at $26,323,144, in 1912. The indications are that the quantity exported from this State will continue to increase. In addition to the steadily increasing demands of consumers in cities and towns now supplied, other cities, such as Louisville in Kentucky and many towns in Indiana, are being piped to be supplied with gas from West Virginia.

The most prolific gas fields of West Virginia are located in Lewis, Harrison, and Ritchie counties, from which large quantities of gas are exported. These counties have many wells of great volume and high pressure which are holding up well. During 1913 drilling operations were very active in this State and a total of 1,038 gas wells and 128 dry holes were completed. In addition to extending the limits of the older gas fields, a new field was discovered in Taylor County, where one well was drilled with a pressure of 1,000 pounds and two others with a pressure of 480 pounds. The counties in which gas-producing fields are located are as follows: Boone, Braxton, Brooke, Cabell, Calhoun, Clay, Doddridge, Gilmer, Hancock, Harrison, Kanawha, Lewis, Lincoln, Logan, Marion, Marshall, Monongalia, Mingo, Nicholas, Pleasants, Putnam, Ritchie, Roane, Taylor, Tyler, Ohio, Upshur, Wayne, Wirt, Wetzel, and Wood.

Considerable gas is produced from oil wells located in Tyler, Ritchie, Brooke, Wetzel, Pleasants, Hancock, and Wood counties. This gas is rich in gasoline, and many plants have been installed for the purpose of extracting the gasoline from the gas. This industry assumed considerable importance in 1913, the production of gasoline from this source being greater in West Virginia than in any other State. Statistics of this industry will be found in another part of this report.

Another important industry which has developed in this State is the manufacture of carbon black from gas. On account of the abundance of gas and the low price at which it can be purchased, these factories have continued to increase until at the close of 1913 there were 18 carbon-black manufacturers operating in this State, to which this business is almost wholly confined. It is estimated that 22,229,335,000 cubic feet of gas, valued at $485,797, was used in this State in the manufacture of carbon black in 1913, as compared with 25,430,749,000 cubic feet, valued at $559,572, in 1912. The average value in 1913 was about 2.2 cents per thousand cubic feet. The quantity of gas required to make 1 pound of carbon black is estimated at from 1,000 to 1,200 cubic feet. On this basis, the quantity of carbon black produced in this State in 1913 would amount to 19,955,434 pounds.

The total number of productive gas wells in West Virginia at the close of 1913 was 6,463, of which 1,038 were completed during that year. The number of gas wells abandoned in 1913 was 108.

The acreage controlled by gas-producing companies in West Virginia at the close of 1913 was 3,155,751 acres, as compared with 3,019,316 acres at the close of 1912.

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In the following table is given a record of the natural-gas industry in West Virginia from 1897 to 1913, inclusive:

Record of natural-gas industry in West Virginia, 1897–1913.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	12	$912,528	[a] 30,015	393	$791,192	47	1	196
1898	19	1,334,023	[a] 28,652	125	914,069	32	4	227
1899	30	2,335,864	[a] 38,137	305	1,310,675	78	6	300
1900	34	2,959,032	[a] 45,943	184	1,530,378	129	6	428
1901	44	3,954,472	[a] 55,808	266	2,244,758	177	8	604
1902	79	5,390,181	29,357	877	2,473,174	142	37	745
1903	88	6,882,359	36,179	1,122	3,125,061	242	43	987
1904	90	8,114,249	44,563	1,005	3,383,515	292	33	1,274
1905	76	10,075,804	45,588	1,417	3,586,008	385	28	1,579
1906	67	13,735,343	51,281	913	3,720,440	263	23	1,831
1907	105	16,670,062	53,807	1,000	[b] 3,757,977	377	59	2,169
1908	138	14,837,130	63,228	1,225	[b] 4,020,282	441	80	2,511
1909	183	17,538,565	70,853	1,907	[b] 5,183,054	801	65	3,232
1910	241	23,816,553	86,778	2,659	[b] 5,617,910	1,002	69	4,052
1911	340	28,435,007	87,438	1,566	[b] 6,240,152	905	117	4,790
1912	406	33,324,475	94,273	1,953	[b] 7,001,331	870	149	5,533
1913	451	34,164,850	101,234	1,834	[b] 7,333,966	1,038	128	6,463

[a] Number of fires supplied. [b] Includes gas consumed in Maryland.

In the following table are given the depth and gas pressure of wells in West Virginia from 1909 to 1913, inclusive, by counties:

Depth and gas pressure of wells in West Virginia, 1909–1913, by counties.

County.	Depth, in feet.	Pressure, in pounds.				
		1909	1910	1911	1912	1913
Boone	1,060–1,780	.....	.....	.....	350– 520	400– 525
Braxton	2,100–3,000	.....	.....	840	.....	.....
Clay	1,400–2,000	240– 525	125– 535	200– 400	300– 600	200– 450
Taylor	1,453–2,800	.....	.....	80– 800	100– 600	400– 1,000
Brooke	1,200–1,905	100– 600	100– 400	0– 50	0– 270	0– 640
Cabell	900–2,325	200– 460	250– 540	250– 500	350– 400	350– 500
Calhoun	824–4,000	60–1,400	18–1,500	35– 655	20– 760	60– 400
Doddridge	1,400–3,000	100– 800	10– 760	100– 750	5– 700	75– 900
Gilmer	1,280–3,181	250– 875	350– 630	640	130– 210	100– 180
Hancock	700–1,880	10– 150	3– 100	1– 60	20– 150	40– 100
Harrison	800–3,300	50– 900	50– 900	50–1,040	40– 900	50– 900
Kanawha	1,200–2,585	500	480– 560	400– 500	250– 600	50– 500
Lewis	1,127–3,000	200– 720	125– 800	60– 950	45– [a] 1,100	50– [a] 1,100
Lincoln	900–2,720	250– 450	400– 500	400– 650	200– 600	400– 560
Logan	1,200–2,200	.....	.....	.....	550– 580	75– 540
Marion	1,500–3,478	125– 580	50– 600	90–1,200	75– 905	40– 500
Marshall	1,000–2,900	200– 300	10– 295	50– 300	6– 300	125– 300
Mingo	800–2,100	.....	.....	300– 600	375– 550	250– 600
Wayne						
Monongalia	1,350–3,500	85– 500	70– 450	60– 700	60– 825	60– 820
Nicholas	1,200–1,300	.....	.....	.....	.....	.....
Ohio	1,500–2,000	.....	.....	40– 125	15– 350	25
Pocahontas	2,000–2,500	.....	.....	.....	.....	.....
Pleasants	900–2,150	100– 250	100– 150	150– 400	50– 300	30– 500
Putnam	900–2,400	300– 800	300– 800	300– 800	.....	.....
Upshur	1,934–2,800			25– 740	480– 600	460
Ritchie	725–2,925	45– 670	20– 800	250– 275	20– 700	30– 700
Roane	1,472–2,350	400– 500	275– 600		320– 465	350– 750
Tyler	1,650–2,700	65– 300	35– 440	50– 100	50– 750	50– 650
Wetzel	1,300–3,560	95– 250	70– 300	0– 200	50– 113	5– 150
Wirt	500–1,875	40– 500	35– 500	10– 450	30– 500	18– 275
Wood	1,030–1,800	250– 540	250– 540	160– 350	300– 520	150– 500

[a] New well.

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KENTUCKY.

The production of natural gas in Kentucky in 1913 was 1,821,526,000 cubic feet, valued at $509,846, as compared with 1,950,881,000 cubic feet, valued at $522,455, in 1912, a slight decrease in both quantity and value.

The principal gas-producing field of the State is in Menifee County, from which the Central Kentucky Natural Gas Co. supplies gas to Lexington, Winchester, Mount Sterling, and Paintsville through the Johnson County Gas Co., and to Paris through the Paris Gas & Electric Co. The United Fuel Gas Co., having wells in Martin County, supplies consumers in Ashland, Buchanan, Catlettsburg, Greenup, Inez, Kinner, Kavanaugh, Louisa, Pollard, Russell, and Warfield. The Cumberland Natural Gas Co., operating in Knox County, supplies consumers in Barboursville. Salyersville is supplied with gas from wells in Magoffin County, this field having been developed in 1913. Russellville, Lewisburg, Diamond Springs, and Central City are supplied with gas from wells in Muhlenberg County, where a number of gas wells have been completed. Meade County has been the chief source of the natural gas supplied for so many years to Louisville by the Kentucky Heating Co., now the Louisville Gas & Electric Co., but the wells are now almost exhausted. A new company, known as the Kentucky Pipe Line Co., had in course of construction in 1913 a 12-inch line, to be 200 miles in length, which will probably be completed to supply Louisville with gas before the close of 1914. The gas will come from the fields of West Virginia and will be distributed by the Louisville Gas & Electric Co. During the last two years Morgan County has developed some very good gas wells, a part of the product of which is supplied to consumers in Cannel City, Caney, and West Liberty. Gas from wells in Breckenridge County is furnished to consumers in Cloverport, and consumers in Burning Springs obtain their supplies from Clay County. A number of consumers in West Point are supplied with gas from wells in Hardin County. Hazel Green is supplied with gas from Wolfe County. It will thus be seen that the productive gas territory of Kentucky is widely scattered. The oil wells of Wayne County produce considerable gas, which is used for field purposes, and there are only a few wells in this county which are exclusively gas wells.

The estimated quantity of gas consumed in Kentucky in 1913 was 5,911,042,000 cubic feet, valued at $1,225,116, an average of 20.73 cents per thousand cubic feet, as compared with 5,102,941,000 cubic feet, valued at $1,070,664, or 20.98 cents per thousand cubic feet in 1912, an increase of 808,101,000 cubic feet in quantity and of $154,452 in value. The difference between the quantity and value of the gas produced and the gas consumed in the State in 1913, which amounted to 4,089,516,000 cubic feet, valued at $715,270, represents the quantity and value of the gas piped from West Virginia—a considerable increase over the imports of gas from West Virginia in 1912, which amounted to 3,152,060,000 cubic feet, valued at $548,209. The indications are that the year 1914 will also show an increase.

Some of the cities and towns in Kentucky which are wholly supplied with gas from West Virginia are as follows: Covington, West Covington, Newport, Bellevue, Dayton, Ludlow, Maysville, and Cold Spring.

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The table giving the distribution of gas consumed in the United States in 1913, by States, shows that Kentucky consumed nearly as much gas for domestic purposes as for industrial purposes, but that the value of gas for domestic consumption was more than three times greater than that for industrial use. The average price of gas per thousand cubic feet consumed for domestic purposes in 1913 was 32.26 cents and for industrial purposes 9.82 cents. The greater portion of the gas consumed in this State for industrial purposes was used for manufacturing.

The number of productive gas wells in Kentucky was 270 at the close of 1913, of which 23 were drilled in that year. The number of dry holes drilled in 1913 was 7, and the number of wells abandoned was 20.

In the following table is given a record of the natural-gas industry in Kentucky from 1906 to 1913, inclusive:

Record of natural-gas industry in Kentucky, 1906–1913.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	45	$287,601	17,216	18	$287,501	.....	.....	166
1907	33	380,176	19,279	239	380,176	31	14	179
1908	38	424,271	21,778	42	424,271	19	23	218
1909	38	485,192	25,639	137	695,577	26	7	212
1910	47	456,293	27,961	112	908,293	23	12	241
1911	74	407,689	41,201	70	901,750	19	8	255
1912	88	522,455	45,603	103	1,070,664	22	27	267
1913	93	509,846	54,446	146	1,225,116	23	7	270

ALABAMA.

Natural gas was produced commercially in Alabama in Fayette, Madison, and Walker counties in 1913, there being a total of 340 domestic and 2 industrial consumers supplied in the towns of Fayette, Jasper, and West Huntsville. Jasper was first supplied with gas in 1913, and this is one of the features that mark the progress of the natural-gas industry in this State. As compared with 1912, the number of consumers supplied in 1913 was more than double, and the income derived from sale of gas was proportionately increased.

Considerable effort has been made and much money spent in trying to find an important oil or gas field in Alabama; the results have not been very encouraging, but the prospectors are hopeful, and the work continues. The gas wells in the Fayette and Walker county fields are holding up very well. The number of productive gas wells in the State at the close of 1913 was 18. One well was flooded and abandoned, but an effort will be made to bring it back, and there is a chance that it may yet be a producer. During 1913 there were 7 dry holes drilled in Alabama, 1 in Fayette County, 1 in Morgan County 4 in Walker County, and 1 in Winston County.

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The depth of the productive gas wells in Alabama varies from 300 to 2,400 feet and the pressure from 25 to 800 pounds.

The statistics of the gas production in this State are included with those of Louisiana.

TENNESSEE.

The value of the natural gas consumed in Tennessee in 1913 was nearly double that of 1912, but the production was very small, only four families being supplied. The gas was produced from wells in Franklin County, where there were 5 wells at the close of 1913. Of these wells, 2 were drilled in 1913 by the Franklin Oil & Fuel Co., and have a depth of from 1,500 to 1,900 feet and are said to be the best wells in the State. This company is drilling a third well.

There are also two gas wells in White County and one gas well in Perry County, from which no gas was produced in 1913.

OHIO.

The State of Ohio, which led all other States in the value of gas consumed in 1912, takes second place in 1913, having been displaced by Pennsylvania. However, the difference in values in the two years was slight—$27,055,824 in 1913, as compared with $27,196,162 in 1912, a decrease of but $140,338. On the other hand, the quantity consumed in Ohio in 1913 was greater than in any previous year. The report shows that 128,204,722,000 cubic feet of gas was consumed in 1913, as compared with 126,854,659,000 cubic feet in 1912, an increase of 1,350,063,000 cubic feet. The reduction in the value in 1913 is explained by the table giving the distribution of gas in 1913 by States, which shows an increased consumption of gas for industrial purposes and a decreased consumption of gas for domestic use. The quantity of gas supplied for domestic consumption in 1913 was 64,732,832,000 cubic feet, valued at $18,658,295, or 28.82 cents per thousand cubic feet, as against 67,150,744,000 cubic feet, valued at $19,420,086, or 28.92 cents per thousand cubic feet, in 1912, and the quantity of gas supplied for industrial consumption in 1913 was 63,471,890,000 cubic feet, valued at $8,397,529, or 13.23 cents per thousand cubic feet, as against 59,703,915,000 cubic feet, valued at $7,776,076, or 13.02 cents per thousand cubic feet, in 1912. Of the total quantity of gas consumed in 1913 for industrial purposes, 49,663,270,000 cubic feet, valued at $6,472,271, was used for manufacturing, and $13,808,620,000 cubic feet, valued at $1,925,258, for other industrial or power purposes.

The quantity of gas produced in Ohio declined from 56,210,052,000 cubic feet, valued at $11,891,299, in 1912, to 50,311,940,000 cubic feet, valued at $10,416,699, in 1913. The difference between the quantity of gas consumed and the quantity of gas produced in the State in 1913, which amounted to 77,892,782,000 cubic feet, shows approximately the quantity of gas piped into the State from West Virginia and Pennsylvania. This was an increase of more than 10 per cent over 1912, when the imports of gas from West Virginia and Pennsylvania were 70,644,607,000 cubic feet. It may be said that only a small proportion of this gas is piped from Pennsylvania.

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Drilling operations were not so active throughout Ohio in 1913 as in 1912, 643 wells having been completed as against 856 wells in 1912; and no new or important gas fields have been reported. The chief source of gas produced in the State continues to be the central Ohio field, comprising the counties of Ashland, Fairfield, Hocking, Knox, Licking, Medina, Richland, and Wayne, which has produced enormous quantities of gas since its development and is still very productive, although reports received from producers indicate a general depreciation of gas wells in this field. One well completed in Ashland County, in 1913, at 2,518 feet, had a rock pressure of 650 pounds and by the close of the year was stationary at 225 pounds. Another well in the same county completed in July, 1912, at a depth of 2,617 feet and under a pressure of 615 pounds, was down to 207 pounds on December 31, 1913. Knox and Licking counties also report reduced pressure and more trouble with water breaking in. It is stated that there are many wells in the Sugar Grove field with a pressure of from 50 to 60 pounds, whose product can not be used on account of the higher line pressure. A test made on September 1, 1913, of the pressure of certain wells located in the central Ohio field, as compared with a test of the same wells made on December 31, 1912, gave the following results: Ninety-seven wells in the Ashland-Lorain field, including the counties of Ashland, Medina, Lorain, Richland, and Wayne, with an average pressure of 560 pounds, showed a pressure of 491 pounds, a reduction of 69 pounds; 297 wells in the Homer field, including Knox and Licking counties, with an average pressure of 153 pounds, showed a pressure of 135 pounds, a reduction of 18 pounds; 54 wells in the Sugar Grove field, including Fairfield and Hocking counties, with an average pressure of 80 pounds, showed a pressure of 86 pounds, a gain of 6 pounds.

In their search for more gas considerable activity was displayed in 1913 by companies drilling in northern Ohio, particularly in Cuyahoga and Lorain counties, which for a number of years have produced gas from many shallow wells, the gas being used for individual consumption. Deep drilling in these counties and in the city of Cleveland resulted in the completion of several wells of great volume and high pressure, the product of which is being utilized for both domestic and industrial purposes. Productive wells have been reported by the Berea Road Gas Co., which has 2 wells; the City Ice Delivery Co., 2 wells; the Glidden Varnish Co., 1 well; Theodore Kundtz, 2 wells; the Lakewood Engineering Co., 1 well; the Lakewood Gas Co., 2 wells; the National Tool Co., 1 well; the Robert R. Rhodes Co., 1 well; and the Winton Motor Car Co., 2 wells. These wells have a depth of from 2,600 to 2,750 feet and pressure of from 300 to 1,000 pounds. One well, having a pressure of 1,040 pounds when completed in September, 1912, had a pressure of only 450 pounds on December 31, 1913. In Lorain County the Pittsfield Gas Co. has completed 10 good wells, part of the product being supplied to the Oberlin Gas & Electric Co. and by it distributed to domestic consumers in Oberlin, Ohio. In Noble County wells are holding up very well, with pressure of 500 to 600 pounds. Developments in Mahoning County resulted in the completion of a few wells whose product will be used to supply North Lima and New Springfield. On the whole the natural-gas industry in Ohio was in a prosperous condition in 1913, although the production did not reach the high mark of 1912.

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The number of productive gas wells in Ohio at the close of 1913 was 5,213, as compared with 5,163 at the close of 1912. A total of 643 wells was drilled in 1913, of which 408 were productive and 235 were dry holes. The number of wells abandoned in 1913 was 358.

The production of gasoline from casing-head gas, the statistics of which are given in another part of this report, is one of the important industries of this State.

In the following table is given a record of the natural-gas industry in Ohio from 1897 to 1913, inclusive:

Record of natural-gas industry in Ohio, 1897–1913.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	157	$1,171,777	[a] 85,368	183	$1,506,454	88	51	729
1898	237	1,488,308	[a] 68,211	349	2,250,706	120	12	806
1899	359	1,866,271	[a] 77,787	691	3,207,286	134	17	929
1900	281	2,178,234	[a] 135,743	1,092	3,823,209	97	19	990
1901	305	2,147,215	[a] 149,709	949	4,119,059	113	35	1,099
1902	451	2,355,458	120,127	786	4,785,766	266	40	1,343
1903	515	4,479,040	197,710	1,786	7,200,867	290	62	1,523
1904	453	5,315,564	232,557	1,136	9,393,843	334	49	1,661
1905	425	5,721,462	274,585	2,955	10,396,833	342	58	1,705
1906	409	7,145,809	310,175	3,316	12,652,520	337	51	[b] 1,977
1907	468	8,718,562	380,489	5,476	15,227,780	431	90	2,942
1908	[c] 970	8,244,835	427,276	3,621	15,166,434	398	124	[d] 3,691
1909	[c] 1,534	9,966,038	450,973	5,260	18,884,312	548	149	[d] 4,260
1910	[c] 1,630	8,626,054	475,505	3,187	21,210,065	466	202	[d] 4,717
1911	[c] 1,900	9,367,347	577,263	3,634	22,792,270	450	191	[d] 4,999
1912	[c] 2,031	11,891,299	641,724	4,414	27,196,162	637	289	[d] 5,163
1913	[c] 2,056	10,416,099	685,956	5,010	27,055,824	408	235	[d] 5,213

[a] Number of fires supplied.

[b] Exclusive of complete report of shallow wells.

[c] Includes 735 producers in Ashtabula, Erie, Huron, Lake, Lorain, and Cuyahoga counties having shallow wells for their own domestic purposes in 1908, 1,239 in 1909, 1,289 in 1910, 1,476 in 1911, 1,579 in 1912, and 1,600 in 1913.

[d] Includes 901 shallow wells located in Ashtabula, Erie, Huron, Lake, Lorain, and Cuyahoga counties in 1908, 1,568 in 1909, 1,541 in 1910, 1,757 in 1911, 1,773 in 1912, and 1,778 in 1913.

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In the following table are given the depth and gas pressure of wells in Ohio from 1909 to 1913, inclusive, by counties:

Depth and gas pressure of wells in Ohio, 1909–1913, by counties.

County.	Depth, in feet.	Pressure, in pounds.									
		1909		1910		1911		1912		1913	
Allen	1,200–1,470										
Ashland	2,500–2,800			663		670		250–	650	90–	300
Ashtabula	400–2,200	5–	300	5–300	0–	275		0–	410		
Athens	440–1,500	160–	280	25–350	25–	350		10–	350	50–	350
Auglaize	1,100–1,300			12– 30	2–	90		5–	110	3–	140
Belmont	778–1,970	200–	300	60–600	40–	150		20–	50	60–	140
Carroll	500–1,434	165–	300	185–350	90–	300		100–	150	90–	150
Clinton	715–				160–	190			160		95
Columbiana	575–1,000	50–	287	55–240	25–	240		25–	350	16–	300
Cuyahoga	337–2,900	2–	100	2– 80	0–	97		0–	a800	0–	a1,000
Darke	850–1,300	5–	25	15–185	2–	250		2–	300	2–	300
Erie	350– 650				20–	40		18–	40		
Fairfield	240–2,800	60–	500	50–280	40–	500		40–	350	16–	320
Guernsey	700–1,500	80–	400	50–300	350–	400			250		300
Muskingum	800–3,350	1,000–	1,100								
Hancock	880–1,800	2–	70	2– 50	0–	200		2–	400	2–	150
Hardin	1,200–1,600	25–	40	20–300	25–	300		75–	300	20–	300
Harrison	460–1,650	5–	400	30–345	10–	110		10–	150	5–	225
Hocking	750–3,300	800–	850								
Huron	400– 800				10–	25		0–	40		
Holmes	600–1,160		225		135–	220		100–	170	80–	165
Jefferson	600–2,026	40–	230	40–250	0–	400		12–	a890	15–	300
Knox	590–3,200	25–	400	80–390	50–	250		15–	250	50–	300
Lake	360–1,700	1–	100	1–135	0–	165		0–	185		
Lawrence	1,834										750
Licking	1,950–3,000	100–	750	80–600	60–	700		80–	400	30–	450
Logan	1,360–1,500	130–	280					20–	180		160
Lorain	338–2,590	0–	940	0–500	0–	a1,150		0–	a900	0–	675
Lucas	1,156–1,750	8–	30	4– 11	5–	100		7–	30	9–	30
Mahoning	650– 750								a160	150–	158
Medina	198–3,000	10–	40	3– 30	5–	875		4–	a1,100	2–	500
Mercer	1,020–1,400	4–	210	1–150	3–	120		1–	100	1–	105
Monroe	650–2,400	25–	500	60–400	100–	400		8–	200	3–	180
Morgan	240–1,650	10–	400	20–450	20–	450		20–	450	15–	450
Noble	484–2,000	150–	700	100–500	200–	650		100–	620	150–	620
Ottawa	1,250–1,900	100–	350	200–450	85–	450		40–	450	80–	250
Perry	650–3,020	50–	900	40–740	50–	250		150–	800	150–	600
Richland	1,950–2,800		450	250–400	150–	300		200–	250		
Sandusky	450–1,400	40–	160	5–175	5–	165		5–	160	5–	150
Seneca	370–1,760	50–	175	25–100	25–	140		20–	110	20–	140
Summit	900–3,350					160		a980–	1,020		
Trumbull	370– 388										10
Tuscarawas	850–1,350			325–385	260–	325		180–	350	160–	475
Van Wert	1,200–1,285		35	40		40			40		
Vinton and Jackson	520– 800		250								
Warren	275–1,000										
Wayne	3,200–3,235								a800	300–	a1,120
Washington	500–2,600	15–	450	15–500	15–	500		15–	600	15–	500
Wood	1,170–1,500			20– 40	10–	15		10–	12	10–	15

a New well.

INDIANA.

One of the important features of the natural-gas industry in the United States in 1913, and one of particular interest to the people of Indiana, was the completion of pipe lines and the successful introduction of natural gas into this State from the gas fields of West Virginia. Although this State has long enjoyed the use of this ideal fuel, it has been evident for some time that the gas fields of the State were gradually being exhausted. In the early days of the natural-gas industry, Indiana was one of the most prolific gas-producing States, but no care was taken to conserve the supply and the waste has been enormous.

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An examination of the following table shows that with the exception of the year 1909, there has been a constant reduction since 1902, although many efforts have been made to find new gas territory.

The construction of pipe lines to transport gas into Indiana was begun in 1913 by the Logan Natural Gas & Fuel Co. A line from Sugar Grove, Fairfield County, Ohio, has been completed to Muncie, Ind., a distance of approximately 160 miles. This line from Sugar Grove to a point about 3 miles north of Dayton, Ohio, is 18 inches in diameter. From that point to Muncie the line is 16 inches in diameter. From Muncie branch lines of 10 and 12 inches in diameter are laid to Anderson and Fairmount to connect with smaller lines supplying Hartford City, Marion, Kokomo, Elwood, Alexandria, Gas City, Tipton, Shelbyville, Greenfield, and other points in central Indiana. A 10-inch line from the 16-inch trunk line has also been constructed to Richmond, Ind., and at a point farther west on the 16-inch line, an 8-inch line has been laid to supply Newcastle. The supply of gas for this service is obtained from Harrison and Lewis counties, W. Va., the lines from those fields being laid and in operation to Sugar Grove, at which point the Indiana lines have been connected.

Before the close of 1913 four companies were purchasing West Virginia gas from the Logan Natural Gas & Fuel Co., and distributing it to consumers in Indiana. The first gas transported from West Virginia to Indiana was turned on by the Central Indiana Gas Co. on the first day of October, the cities of Muncie, Marion, Anderson, Alexandria, Hartford City, and Elwood being supplied. At a later date the Indiana Gas Light Co. turned natural gas, brought from West Virginia, into its mains and began to supply Noblesville and Tipton. The Interstate Public Service Co. began the distribution of West Virginia gas to consumers in Newcastle about December, and the town of Richmond was supplied about the same time with West Virginia gas by the Richmond Light, Heat & Power Co. The rate charged for West Virginia gas by the above-named companies is from 30 to 40 cents per thousand cubic feet, according to quantity used. The gas is supplied for both domestic and manufacturing purposes, the number of consumers connected to these lines on December 31, 1913, being 19,832 domestic consumers and 67 manufacturing or industrial consumers.

During the year 1913 several gas-producing companies discontinued business in this State on account of shortage of gas and reduced pressure, there not being sufficient gas for commercial purposes, and their wells have either been abandoned or sold to the farmers upon whose lands they are located, and by whom they will be used for domestic purposes. The table giving the distribution of gas consumed in 1913, by States, shows that Indiana consumed for domestic purposes 2,588,120,000 cubic feet of gas, valued at $824,430, and that the quantity consumed for industrial purposes was only 632,765,000 cubic feet, valued at $123,848, this gas being principally utilized for power in the operation of gas engines and under boilers.

The total quantity of gas consumed in Indiana in 1913 was 3,220,885,000 cubic feet, valued at $948,278, an average price of 29.44 cents per thousand cubic feet, as compared with 3,618,077,000 cubic feet, valued at $1,014,295, an average of 28.03 cents per thousand cubic

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feet in 1912. These figures of gas consumption can only be said to be approximate as much of the gas consumed in this State is used without measurement and only an estimate of the quantity consumed can be made. The failure to use meters in this State was one of the causes for the great waste of gas.

It will not be possible to give separately the figures of gas production in this State in 1913, since there is but one company piping gas into the State. Therefore, the figures given as the production of gas in Indiana include the quantity and value of the gas piped into the State from West Virginia.

The report shows that the number of productive wells in this State was 2,370 at the close of 1913, as compared with 2,547 at the close of 1912. During the year 93 wells were drilled, of which 69 were productive and 24 were dry holes. The number of gas wells abandoned was 246.

In the following table is given a record of the natural-gas industry in Indiana from 1897 to 1913, inclusive:

Record of natural-gas industry in Indiana, 1897–1913.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	452	$5,009,208	[a] 214,750	935	$8,945,307	419	66	2,881
1898	533	5,000,969	[a] 173,454	1,867	4,682,401	706	111	3,325
1899	571	6,680,370	[a] 181,440	1,741	[b] 5,833,370	838	109	3,909
1900	670	7,254,339	[a] 181,751	2,751	[b] 6,412,307	861	156	4,546
1901	656	6,954,766	[a] 153,869	2,570	[b] 6,276,119	985	208	4,572
1902	929	7,081,344	101,481	3,282	[b] 6,710,080	1,331	205	5,830
1903	924	6,098,364	90,118	1,020	[b] 5,915,367	895	242	5,514
1904	846	4,342,409	84,862	390	[b] 4,282,409	706	153	4,684
1905	740	3,094,134	63,194	231	[b] 3,056,634	252	74	3,650
1906	578	1,750,715	47,368	156	[b] 1,750,755	159	46	3,523
1907	687	1,572,605	46,210	218	[b] 1,570,605	185	56	3,386
1908	823	1,312,507	42,054	216	[b] 1,312,507	187	41	3,223
1909	1,010	1,616,903	40,465	369	[b] 1,616,903	190	70	2,988
1910	1,027	1,473,403	36,054	282	[b] 1,473,403	69	33	2,955
1911	1,094	1,192,418	31,576	143	[b] 1,192,418	110	32	2,744
1912	1,140	1,014,295	27,165	140	[b] 1,014,295	96	39	2,547
1913	1,100	[c] 948,278	39,776	239	[c] 948,278	69	24	2,370

[a] Number of fires supplied.
[b] Includes value of gas consumed in Chicago, Ill.
[c] Includes value of gas piped from West Virginia and consumed in Indiana.

In the following table are given the depth and gas pressure of wells in Indiana from 1909 to 1913, inclusive, by counties:

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Depth and gas pressure of wells in Indiana, 1909–1913, by counties.

County.	Depth, in feet.	Pressure, in pounds.				
		1909	1910	1911	1912	1913
Adams	1,000–1,050	250			100	40– 50
Bartholomew	864– 990	50–175	50–250	150–175	75–125	85–165
Blackford	850–1,100	1– 25	1– 10	0– 30	0– 12	0– 8
Clark	128– 244				27	
Daviess, Martin	300– 600	0– 20	0– 60	9–160	7–150	5–165
Decatur	700–1,200	0–325	0–315	0–325	5–330	5–350
Delaware	728–1,500	1– 55	0– 70	0– 75	0– 60	0– 50
Franklin	728– 730					60
Grant	830–1,200	2– 45	2– 50	0–180	2–180	5–200
Hamilton	800–1,280	5–185	15–180	15–225	8–235	8–225
Hancock	700–1,100	0–100	0–100	3–280	5– 80	8–125
Harrison	320– 764			60–110	112	50
Henry	800–1,200	5–100	0– 90	0– 80	0–100	5–150
Howard	800–1,100	0–200	0–220	20–250	10–180	35–200
Jay	900–1,600	0– 50	0– 40	0–110	0–220	0– 50
Jefferson	1,360			10		20
Madison	800–1,200	0–200	0–190	0–180	1–175	0–175
Miami	900–1,000	0– 10	0– 40			
Marion, Ripley	880–1,050	35	40	180–285	150–250	100–160
Pike	1,000–1,400	300–550	125–500	100–480	60–300	25–450
Randolph	900–1,300	0–175	0–180	2–300	4–140	2–190
Rush	700–1,400	9–375	20–325	0–300	12–300	10–300
Shelby	650–1,020	10–310	1–375	1–300	10–366	15–300
Spencer	1,025				410	
Sullivan	698– 780	250	200	50–100	40–110	30– 50
Tipton	750–1,100	18–180	10–230	15–190	3–180	5–125
Wayne	800–1,150	20–300	50–240	25–150	25– 70	45– 75

ILLINOIS.

It is estimated that the quantity of gas produced in Illinois in 1913 was 4,767,128,000 cubic feet, valued at $574,015, as compared with 5,603,368,000 cubic feet, valued at $616,467, in 1912, a decrease of 836,240,000 cubic feet in quantity and of $42,452 in value. The table giving the distribution of gas in the United States in 1913, by States, shows that the decline in Illinois has been greatest in gas supplied for domestic consumption. The value of the gas utilized for domestic purposes in 1913 was 898,677,000 cubic feet, valued at $230,850, as compared with 1,236,162,000 cubic feet, valued at $291,987, in 1912, the number of domestic consumers also decreasing from 10,691 in 1912 to 10,423 in 1913. The quantity of gas consumed for industrial purposes in 1913 was 3,868,451,000 cubic feet, valued at $343,164, as compared with 4,367,206,000 cubic feet, valued at $324,480, in 1912. It will be seen that more than four times as much gas was used for industrial purposes in Illinois in 1913 as for domestic purposes, but that the value of the gas used industrially was greater by less than half. Of the gas consumed industrially five times as much was used for power as for manufacturing. The greater part of the gas consumed for power was used for gas engines and boilers for operating and drilling in the oil fields and by refineries. Much of the gas used for power was not metered, so that the figures of industrial consumption are largely estimated. Many of the oil wells in Illinois produce gas in considerable quantity, the surplus gas in some cases being sold to the gas-distributing companies for distribution to domestic consumers. Gas from some of the oil wells is also rich in gasoline and a few plants have been installed for the extraction of gasoline

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from the gas, statistics of which industry will be found in another part of this report.

The commercial gas wells of Illinois are located in Bond, Clark, Crawford, McLean, and Lawrence counties, the towns supplied in 1913 being practically the same as in 1912. The gas from wells in Bond County is supplied to Greenville. One gas well in McLean County is supplying consumers in Heyworth. Carlinville was supplied with gas from wells in Macoupin County in 1913, but the wells in this county were abandoned before the close of 1913.

A portion of the gas produced in Illinois is piped out of the State and supplied to consumers in Vincennes, Ind. However, the figures of this gas consumption are included with those of Illinois.

The average price received per thousand cubic feet for gas supplied for domestic consumption in Illinois in 1913 was 25.69 cents as compared with 23.62 cents in 1912, the rate charged varying from 20 to 30 cents. The average price per thousand cubic feet for gas supplied for industrial consumption in Illinois in 1913 was 8.87 cents, as compared with 7.43 cents in 1912, the rate charged varying from 5 to 20 cents.

The report shows little change in the number of productive gas wells since the last report. During the year 1913 a total of 179 wells were completed by gas-producing companies, of which 60 were productive and 119 dry holes, the number of productive gas wells being 455 at the close of the year. The number of gas wells abandoned in 1913 was 58. None of the gas wells in Illinois, as reported, exceeds a depth of 1,900 feet, the Lawrence County wells being the deepest. The pressure of wells reported is not great, the highest pressure of any well at the close of 1913 being 350 pounds, and this of a well completed in 1913.

Included in the 455 wells reported are 218 shallow gas wells in the following-named counties: Bureau, 105; Champaign, 9; Dewitt, 10; Edgar, 15; Lee, 12; Logan, 2; Montgomery, 2; Morgan, 4; Pike, 59; each producing scarcely more than enough gas for one family. The value of the gas produced from these wells and consumed in 1913 is estimated to have been $15,176.

In the following table is given a record of the natural-gas industry in Illinois from 1906 to 1913, inclusive:

Record of natural-gas industry in Illinois, 1906–1913.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	66	$87,211	1,429	2	$87,211	.....	.....	200
1907	128	143,577	2,126	61	143,577	94	41	293
1908	185	446,077	[a] 7,377	[a] 204	[a] 446,077	121	42	400
1909	194	644,401	[a] 8,458	[a] 518	[a] 644,401	56	11	423
1910	207	613,642	[a] 10,109	[a] 261	[a] 613,642	64	31	458
1911	225	687,726	[a] 10,078	[a] 293	[a] 687,726	69	78	458
1912	223	616,467	[a] 10,691	[a] 212	[a] 616,467	56	147	453
1913	231	574,015	[a] 10,423	[a] 279	[a] 574,015	60	119	455

[a] Includes number of consumers and value of gas consumed in Vincennes, Ind.

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In the following table are given the depth and gas pressure of wells in Illinois from 1909 to 1913, inclusive, by counties:

Depth and gas pressure of wells in Illinois, 1909–1913, by counties.

County.	Depth, in feet.	Pressure, in pounds.				
		1909	1910	1911	1912	1913
Bond	1,050–1,100	200–580	200–750	100–350	40–410	35–355
Lawrence	700–1,900					
Bureau	98– 357	0– 23	0– 23	0– 42	0– 80	0– 42
Champaign	80– 140	.....	15– 32	15– 30	0– 20	0– 30
Clark	250– 610	38–100	35– 45	10– 60	15–105	0– 30
Crawford	400–1,550	45–275	20–225	10–150	20–200	20–350
Cumberland	500– 575	40	.....	.....	.....	.....
Dewitt	85– 127	.....	25– 50	20– 50	0– 50	0– 25
Edgar	230– 600	.....	75–127	50– 90	75–130	50–135
Lee	126– 280	.....	18– 28	19– 28	12– 28	12– 28
Logan	84– 90	.....	.....	.....	.....	.....
McHenry	160– 372	.....	.....	10– 22	.....	.....
McLean						
Macoupin						
Montgomery	55– 60	.....	.....	.....	.....	1– 2
Morgan	260– 400	.....	.....	0–100	0–100	0– 96
Pike	89– 350	3– 7	4– 10	1– 20	0– 10	0– 9

KANSAS.

The following table shows that in point of the value of its gas production the State of Kansas takes fifth place in 1913, as in 1912, although the production decreased from 28,068,370,000 cubic feet, valued at $4,264,706, in 1912, to 22,884,547,000 cubic feet, valued at $3,288,394, in 1913, a decrease of 5,183,823,000 cubic feet in quantity and of $976,312 in value. This reduction was anticipated, as the gas fields of this State have been declining and no large gas fields have been discovered to augment the failing supply. This State, as well as Missouri, depends largely upon the gas fields of Oklahoma for its gas. During the year 1913 more gas was piped into these States from Oklahoma than was produced in Kansas, although the quantity imported was very much less than that of previous years. The quantity of gas piped from Oklahoma to Kansas and Missouri in 1911 was 39,061,737,000 cubic feet, valued at $4,639,167; in 1912, 32,249,916,000 cubic feet, valued at $4,257,152; and in 1913, 23,768,374,000 cubic feet, valued at $3,695,408—these figures representing the values at the point of consumption.

The total quantity of gas consumed in Kansas and Missouri in 1913 was 46,652,921,000 cubic feet, valued at $6,983,802, an average price of 14.97 cents per thousand cubic feet, as compared with 60,318,286,000 cubic feet, valued at $8,521,858, an average price of 14.13 cents per thousand cubic feet, in 1912. Of this total consumption there was supplied to 195,131 domestic consumers in 1913 some 20,550,852,000 cubic feet of gas, valued at $4,977,137, an average price of 24.22 cents per thousand cubic feet, while 26,102,069,000 cubic feet, valued at $2,006,665, an average price of 7.69 cents per thousand cubic feet, was supplied to 950 manufacturing and other industrial consumers.

The table of the distribution of gas for industrial purposes in 1913 shows that Kansas and Missouri utilized for manufacturing purposes 17,110,874,000 cubic feet of gas, valued at $1,136,007, and that 8,991,195,000 cubic feet, valued at $870,658, was utilized for power. The

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gas consumed in Kansas for manufacturing purposes was principally used at zinc, cement, brick, and glass works.

It is estimated that 8,481,882,000 cubic feet of gas, valued at $453,349, was consumed by zinc smelters in Kansas in 1913, as compared with 12,474,938,000 cubic feet, valued at $666,892, in 1912, and with 13,186,505,000 cubic feet, valued at $543,301, in 1911. The zinc operators in Kansas and the consumers of this gas in 1913 were as follows: American Zinc, Lead & Smelting Co., Chanute Zinc Co., Edgar Zinc Co., Granby Mining & Smelting Co., Kansas Zinc Co., Altoona Zinc Smelting Co., Laharpe Spelter Co., Prime Western Spelter Co., United Zinc & Chemical Co.

The consumption of gas at cement plants in Kansas in 1913 is estimated at 3,018,975,000 cubic feet, valued at $186,858, as compared with 7,140,009,000 cubic feet, valued at $437,042, in 1912, and with 13,272,417,000 cubic feet, valued at $728,911, in 1911. Plants formerly using gas are now burning coal or oil. Operators of cement plants at which gas was used in 1913 were the Ash Grove Lime & Portland Cement Co., the Altoona Portland Cement Co., the Iola Portland Cement Co., and the Western States Portland Cement Co.

The quantity of gas consumed for brick manufacture (including stoneware) in Kansas in 1913 is estimated at 3,492,336,000 cubic feet, valued at $269,618. This was a considerable increase over the consumption of 1912, which was estimated at 2,768,874,000 cubic feet, valued at $171,644. The glass plants of this State consumed 559,983,000 cubic feet of gas, valued at $46,005, in 1913, as compared with 922,142,000 cubic feet, valued at $57,047, in 1912.

Drilling was much more active in Kansas in 1913 than in 1912, resulting in the completion of 506 productive gas wells, but the number of wells abandoned in 1913 was greater than in 1912. About 1½ miles east and south of Liberty, Montgomery County, considerable drilling was undertaken in 1913, and more than 30 gas wells have been completed in this district with an estimated total daily production of over 100,000,000 cubic feet. These wells are shallow, averaging 500 feet, with from 60 to 90 feet of good gas sand, and the big wells are in this shallow sand. The pressure of the wells in this field is about 100 pounds. Some gas from the Bolton field, Montgomery County, was added to the supply of this State in 1913, the product being piped to consumers in Independence. In Chautauqua County a new field was discovered, and 18 gas wells were completed at a depth of from 650 to 850 feet and with a pressure of from 240 to 300 pounds. A few wells drilled in Butler County in 1913 will produce nitrogen gas (80 per cent N.) at 500 to 520 feet, and fuel gas at 1,320 to 1,460 feet. The daily capacity of these wells is from 1,500,000 to 2,500,000 cubic feet of fuel gas and 4,000,000 cubic feet of nitrogen gas. There is no market for nitrogen gas.

There was in this State at the close of 1913 a total of 2,297 productive gas wells, of which 506 were completed in 1913. The number of dry holes drilled in 1913 was 253, and 315 gas wells were abandoned.

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In the following table is given a record of the natural-gas industry in Kansas from 1897 to 1913, inclusive:

Record of natural-gas industry in Kansas, 1897–1913.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1897	10	$105,700	[a] 3,956	20	$105,700	16	8	90
1898	29	174,640	[a] 6,186	44	174,640	34	18	121
1899	31	332,592	[a] 10,071	71	332,592	44	22	160
1900	32	356,900	[a] 9,703	65	356,900	54	15	209
1901	48	659,173	[a] 10,227	72	659,173	71	35	276
1902	80	824,431	13,488	91	824,431	144	63	404
1903	120	1,123,849	15,918	143	1,123,849	295	66	606
1904	190	1,517,643	27,204	298	1,517,643	378	135	1,029
1905	171	2,261,336	46,852	601	2,265,945	340	157	1,142
1906	130	4,010,986	79,270	990	[b] 4,023,566	331	99	1,496
1907	196	6,198,583	149,327	1,605	[b] 6,208,962	361	163	1,760
1908	212	7,691,587	168,855	1,162	[b] 7,691,587	403	208	1,917
1909	199	8,293,946	182,657	1,160	[b] 8,356,076	452	214	2,138
1910	204	7,755,367	186,333	1,412	[c] 9,335,027	392	195	2,149
1911	232	4,854,534	199,523	907	[c] 9,493,701	301	152	2,033
1912	253	4,264,706	195,446	1,104	[c] 8,521,358	435	200	2,106
1913	305	3,288,394	195,131	950	[c] 6,983,802	506	253	2,297

[a] Number of fires supplied.
[b] Includes gas taken from Kansas and consumed in Missouri.
[c] Includes gas taken from Kansas to Missouri; also gas piped from Oklahoma to Kansas and Missouri.

In the following table are given the depth and gas pressure of wells in Kansas from 1909 to 1913, inclusive, by counties:

Depth and gas pressure of wells in Kansas, 1909–1913, by counties.

County.	Depth, in feet.	Pressure, in pounds.				
		1909	1910	1911	1912	1913
Allen	600–1,300	5–300	15–350	5–351	10– 300	5– 260
Anderson	230– 770	65–200	40–150	60–225	30– 240	65– 250
Bourbon	200– 710	75	35– 45	40	40	75
Chase	64–1,100	17–300	10–350	1–400	7– 80	3– 95
Crawford	135– 625	55– 80	4– 65	20– 40	15– 50	40– 50
Cowley	1,400–1,500					
Chautauqua	290–1,300	60–500	40–500	25–250	50– 300	35– 410
Douglas	350– 380	40–180	10–100	30–120	10– 280	20– 60
Johnson	130– 870					
Ellsworth	950–1,250	.....	.....	.....	125– 270	240– 270
Elk	500–1,400	40–200	100–225	100–225	100	90– 100
Butler	1,330–1,500	40–500	40–550	65–450	60–[a] 525	550–[a] 560
Woodson	1,015–1,150					.....
Greenwood	350	.....	.....	.....	.....	.....
Labette	350–1,000	60–125	50–160	25–235	23– 185	20– 240
Linn	85– 750	10–150	12–130	22–110	6– 70	20– 100
Franklin	160– 865	20–200	75–210	50–220	3– 260	1– 500
Miami						
Montgomery	160–1,600	10–350	3–295	5–350	2–[a] 515	5– 700
Neosho	490–1,200	25–350	35–300	20–287	28– 250	15– 325
Wilson	250–1,300	25–400	12–400	20–380	15– 380	15– 285
Wyandotte	271– 800	150–250	50–200	40–250	40– 125	30– 125

[a] New wells.

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MISSOURI.

Returns received from gas producers in Missouri show that the total value of the gas produced from wells and consumed in that State in 1913 was $6,795, as compared with $11,576 in 1912, a reduction of $4,761.

The gas wells in Missouri are located in Bates, Cass, and Jackson counties. The wells are shallow, ranging in depth from 100 to 565 feet, and have a pressure of from 20 to 168 pounds. With few exceptions the wells are used by the persons who had them drilled and are supplying but one family each. A small quantity of gas was supplied commercially in this State in 1913. For a portion of the year 1913 domestic consumers in Rich Hill were supplied with gas from wells in Bates County, but these wells were exhausted and abandoned in August of that year. Consumers in Belton were supplied with gas from wells located in Cass County, and consumers in Martin City were supplied with gas from wells located in Jackson County.

During 1913 the number of domestic consumers supplied with gas in Missouri was 342, and the number of industrial consumers supplied was 7. The gas consumed for industrial purposes was used for the operation of gas engines.

The number of gas wells in this State at the close of the year 1913 was 60, as compared with 70 at the beginning of the year. Six gas wells were drilled, but 16 wells were abandoned. All of the wells abandoned are located in Bates County but two, one of which is in Cass County, the other in Jackson County.

OKLAHOMA.

The report shows that Oklahoma reached its maximum output of natural gas in 1913, showing gains in quantity and value of product as compared with 1912, the declining wells of the State being more than offset by the discovery of new gas fields and the extension of gas territory to the west and south. One of the most important developments of this State is that of the Cushing gas field in Creek County, where the volume and pressure are very great. This is conceded to be one of the best gas fields of the State, the wells varying from 715 to 2,200 feet in depth and reported to have as many as six producing gas sands. Although considerable gas was taken from the wells of this field in 1913 and marketed by the Creek County Gas Co., the town of Cushing being supplied from this source, additional pipe lines were under construction to this field at the close of 1913, through which the gas is to be supplied to the large gas-distributing companies of the State. The gas of this field is also rich in gasoline and two plants have been installed at Drumright, the Consumers Refining Co., and the Cushing Gasoline Co., for the extraction of gasoline from casing-head gas. Two gas wells completed in Creek County in 1913 at depths of 2,014 and 2,134 feet had a rock pressure of 820 and 900 pounds, respectively.

A very large acreage and gas property was opened in McIntosh County in 1913, and the indications are that it is one of the best gas fields of the State; but there is no market yet for all of the product. The town of Eufaula and the Henryetta gas plant are using gas from this field.

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Information furnished by the Commissioner of Indian Affairs concerning gas operations on the Osage Reservation in 1913 show that the gas wells have decreased greatly in volume. Of a total of 31 gas wells in service on January 1, 1913, with a total volume of 113,402,930 cubic feet, only 26 wells were productive of gas on January 1, 1914, with a total volume of 42,044,831 cubic feet. During the year 3 gas wells were exhausted and 2 gas wells were abandoned on account of water. Of a total of 11 gas wells completed in 1913 with a total initial volume of 28,538,943 cubic feet, 7 were productive on January 1, 1914, with a total volume of 12,119,400 cubic feet, 4 of the wells having been exhausted. While there was this great loss in volume, there was also a corresponding loss in static pressure, which further reduces the efficiency of the remaining volume in the wells.

The gas produced on the Osage Reservation by the Indian Territory Illuminating Oil Co. is supplied through the Osage Producers Co. to domestic consumers in Avant, Bigheart, and Ochelata; to zinc smelters through the Smelter Gas Co.; to the Quapaw-Wichita Co. for distribution to consumers; and large quantities are consumed by operators for field purposes.

The gas-producing counties of Oklahoma remained about the same in 1913 as in 1912. Gas produced from Kay County wells is supplied to domestic consumers in Ponca City, Tonkawa, Newkirk, and Kildare, and to the glass works at Ponca City. In Okfuskee County a small quantity of gas is supplied to domestic consumers in Okemah. A considerable quantity of gas produced from wells in Okmulgee, Tulsa, Rogers, and Washington counties is piped to consumers in Kansas and Missouri by the large gas-distributing companies. A new gas field was developed in Stephens County, where 10 gas wells have been completed of 702 to 907 feet in depth and with a pressure of 250 to 330 pounds, and they show no evidence of exhaustion. Duncan, Marlow, and Lawton were supplied with gas from this field in 1913 and some of these wells were shut in. Some developments in progress in Tulsa County in 1913 discovered gas in several wells at a depth of 1,600 feet with a pressure of 300 pounds. No gas has yet been marketed from these wells. Several gas wells in Washington County were exhausted in 1913. The staying qualities of the Bartlesville sand are not reported good. Some of these wells have been drilled deeper and are now oil wells. In the Healdton field, Carter County, gas has been discovered at a depth of 710 to 725 feet under 300 pounds pressure, one well completed in December having a volume of 33,000,000 cubic feet daily.

Gas pools are constantly being exhausted by waste through oil wells, and to eliminate this waste and conserve the gas in Oklahoma the Federal Government sent two experts from the Bureau of Mines to this State in 1913 to show the operators how to prevent waste by a certain system of drilling and to prove that gas sands may without waste be drilled through to lower oil strata. At first they were met with indifference by the operators, some believing their method was not applicable in Oklahoma, while others feared an increased cost of drilling. Work was begun in the Cushing field and the demonstrations have been successful. The experts directed the drilling of two wells in which there would have been a combined waste of more than 20,000,000 cubic feet of natural gas daily under the old methods.

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They succeeded in shutting off the gas in those wells and drilled the wells below the gas stratum and into the oil. They also directed the drilling of other wells past the stratum and without waste of the gas. The system consists in brief in pumping a mud-laden fluid into the well in such a way that it stops the gas from penetrating the well. In the past, it is asserted, in a great many wells drilled in the Cushing field in the gas zone, it was found impossible to drill entirely through the gas formation, owing to the pressure and volume of the gas. In several places it was necessary to shut down the well, and the money spent in drilling was lost. It is asserted that the method urged by the Government will cost the oil men less and that there will be less risk than with the method which has been in vogue. The adoption of this new method, it is said, will under certain conditions prevent the entrance of water, which was threatening the future production of oil in this State.

Oklahoma was the third State in point of gas production in 1913, having produced 75,017,668,000 cubic feet of gas, valued at $7,436,389, an average price of 9.91 cents per thousand cubic feet, as compared with 73,799,319,000 cubic feet in 1912, valued at $7,406,528, an average price of 10.04 cents per thousand cubic feet. It will also be noted that nearly one-third of this gas, or 23,768,374,000 cubic feet, was piped out of the State to Kansas and Missouri. The exportation of gas in 1913 was very much less than in 1912, when 32,249,916,000 cubic feet were piped from the State, showing conclusively the increasing markets and uses for the gas within the State.

The quantity of gas consumed in Oklahoma in 1913 was 51,249,294,000 cubic feet, valued at $3,740,981, an average price of 7.3 cents per thousand cubic feet, as compared with a consumption of 41,549,403,000 cubic feet in 1912, valued at $3,149,376, an average price of 7.58 cents per thousand cubic feet. Of the total quantity of gas consumed in the State in 1913, the supply for domestic consumption was 7,039,196,000 cubic feet, valued at $1,256,818, an average price of 17.85 cents per thousand cubic feet, and for industrial consumption was 44,210,098,000 cubic feet, valued at $2,484,163, or 5.62 cents per thousand cubic feet; in 1912 the quantity of gas supplied for domestic consumption was 6,500,062,000 cubic feet, valued at $1,288,894, an average price of 19.83 cents per thousand cubic feet, and for industrial consumption 35,049,341,000 cubic feet, valued at $1,860,482, or 5.31 cents per thousand cubic feet.

The table of distribution of gas for industrial purposes in 1913 shows that 22,947,560,000 cubic feet, valued at $1,083,154, was supplied for manufacturing and 21,262,538,000 cubic feet, valued at $1,401,009, for other industrial or power purposes, the quantity and value of gas supplied for both classes of industrial consumption being greater in 1913 than in 1912, when 20,915,974,000 cubic feet, valued at $954,498, was supplied for manufacturing and 14,133,367,000 cubic feet, valued at $905,984, was supplied for other industrial or power purposes.

It is estimated that 14,596,005,000 cubic feet of gas, valued at $575,086, was consumed by zinc smelters and brick, glass, and cement plants in Oklahoma in 1913. Another use for natural gas in this State was the manufacture of carbon black, there being one plant in operation in 1913. Large quantities of gas were consumed in 1913 in operating gas engines and boilers in the oil fields and elsewhere,

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for drilling, pumping, and pipe-line stations, and for cotton gins and refineries. The production of gasoline from casing-head gas has become quite an industry in this State, statistics of which will be found in another portion of this report.

The number of productive gas wells in Oklahoma at the close of 1913 was 1,052, as compared with 936 at the close of 1912. In all 423 productive gas wells and 298 dry wells were drilled and 307 wells were abandoned in 1913.

In the following table is given a record of the natural-gas industry in Oklahoma from 1906 to 1913, inclusive:

Record of natural-gas industry in Oklahoma, 1906–1913.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	50	$259,862	8,391	202	$247,282	81	33	239
1907	107	417,221	11,038	277	406,942	99	41	344
1908	115	860,159	17,567	356	860,159	73	40	374
1909	131	1,806,193	32,907	1,527	1,743,963	97	35	454
1910	168	3,490,704	38,617	1,557	1,911,044	93	58	509
1911	204	6,731,770	44,854	1,507	2,092,603	303	143	732
1912	242	7,406,528	47,017	1,651	3,149,376	329	197	936
1913	347	7,436,389	49,308	1,793	3,740,981	423	298	1,052

In the following table are given the depth and pressure of gas wells in Oklahoma from 1909 to 1913, inclusive, by counties:

Depth and gas pressure of wells in Oklahoma, 1909–1913, by counties.

County.	Depth, in feet.	Pressure, in pounds.				
		1909	1910	1911	1912	1913
Hughes	1,000–2,000				200	10–350
Carter	590–1,840					
Cherokee	600– 650	50–350	60–100	48–150		
Comanche	380– 400					
Craig	500					
Latimer	1,575			40–470		
Sequoyah	1,200					
Creek	400–2,500	50–900	40–450	20–700	40–850	20–900
Kay	436–1,600	60–385	60–375	40–390	165–365	40–650
Kiowa	350– 825		35	10– 50		
Le Flore	1,300–2,200		350	300–355	350–355	300–375
McIntosh	962–2,700				150–600	150–400
Marshall	480– 525					
Muskogee	800–1,910	130–160	50–500	18–225	15–350	10–350
Nowata	450–1,700	120–500	70–100	60–450	25–150	25–300
Okfuskee	1,450					
Okmulgee	760–2,600	150–700	150–800	100–700	300	80–a 800
Osage	900–2,200	300–850	200–650	150–650	200–780	100–700
Pawnee	1,200–2,560	160–260	150–200	200–450	40–800	
Rogers	380–1,250	50–550	125–530	90–480	40–525	25–500
Stephens	702– 907				300–325	250–330
Tulsa	580–2,000	50–700	50–650	80–400	50–625	100–650
Wagoner	750–1,700	210–600	90–120	100–300		
Washington	425–2,260	60–800	80–740	15–620	10–250	19–350

a New well.

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LOUISIANA.

One of the most important gas fields ever discovered is the Caddo field in Louisiana, and probably more gas has been wasted in this field than in any other. However, these conditions have now been changed and the waste of gas in this State very much lessened by the closing of the three wild wells, which had become famous in this field. After the wild well in the Caddo field was "killed" in 1911 the State Conservation Commission headed a movement to cap the wild gasser at Oil City, which for more than five years has wasted an inestimable quantity of gas. An agreement was reached whereby the commission was to undertake the task and to have the cooperative support of the producers in the field. The crater of the well was first explored, but it was soon found impracticable to close the well from the top. The commission then let a contract for the drilling of a relief well to tap the wild well in the gas-sand stratum from which it was fed. After cutting into the stratum the plan was to pump in mud-laden water and choke the well, the process then to be reversed and the relief well used to reduce the pressure of the wild well, in the hope of being able to get to the original casing of the wild well and cap it. The commission was successful and the wild well succumbed to the water pressure from the neighboring relief well. The closing of this well was accomplished about October 1, 1913, and establishes an important means of conserving the gas of this State. The Dixie well, after flowing gas since September 1, 1907, was choked by salt water and ceased to flow September 18, 1913. The gas pressure had been gradually diminishing and the flow of salt water increasing. The closing of these wild wells has put a stop to any appreciable waste of gas in the Caddo field.

The Caddo gas field is the chief source of gas production in Louisiana, and the most important gas producers in this field are the Arkansas Natural Gas Co. and the South Western Gas & Electric Co., the former company supplying gas to consumers in many cities and towns in Arkansas as far north as Little Rock, a distance of some 200 miles. The South Western Gas & Electric Co., through its branches, the Caddo division, the Shreveport division, and the Texarkana division, is supplying gas to many towns in Louisiana, including Shreveport, Texarkana, Blanchard, Mooringsport, Lewis, Oil City, Vivian, Mystic, and Rodessa, also Ravenna, Ark., besides supplying gas to the Atlanta Gas Co., which is supplying consumers in Atlanta and Queen City, Tex., and the Texarkana Gas Co., which is supplying consumers in Texarkana, Bloomburg, and Cass, Tex. Other gas producers are the Red River Gas Co., supplying consumers in Dixie and Belcher; the Commercial Gas & Oil Co. and the Shreveport Natural Gas Co., both in Shreveport; and the Louisiana-Texas Natural Gas Co., supplying gas through the Marshall Gas Co. to consumers in Marshall and Leigh, Tex. Many of the oil operators of this field have gas wells, the product of which is used and sold for field purposes, in addition to supplying a considerable quantity to the large gas-distributing companies for distribution to consumers. Much of the gas used and sold in the field is supplied at a flat rate and only approximate figures can be given of its production; therefore, the quantity of gas used for power purposes must be considered an estimate.

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In De Soto Parish an important gas field has been developed by the Mansfield Gas Co., from whose wells gas is supplied to domestic and industrial consumers in Mansfield.

Other parishes in Louisiana in which gas was produced and used in 1913 were Lafourche and Ouachita, both of which had a small gas production utilized for power purposes. Two wells drilled in Lincoln Parish were abandoned. Two wells drilled in Rapides Parish were also without results and were abandoned. Mr. I. N. Knapp says:

In Terrebonne Parish there are many surface gas escapements and in all some 12 wells have been drilled, 4 being within a mile of the Lirette (discovery) well. There is abundance of gas in the thin sand layers or lenses between clay or shales all the way from 1,500 to 1,900 feet. The closed pressure (original) is 650 pounds. Some of the sands are loose and some are true gas sands; that is, sands more or less cemented. The layers of clay will squeeze into the screen as soon as the pressure is reduced and shut off the gas. Also in the productive horizon it is uncertain which is gas sand or which salt-water sands. It is impossible to distinguish in drilling with the rotary, and it is impossible to drill in any other way. There is a world of gas here, but not available.

The field has been practically abandoned for the present.

The total value of the gas produced in Louisiana and Alabama in 1913, and consumed for domestic and other purposes, was $2,119,948, as compared with $1,747,379 in 1912, a gain of 21.3 per cent. Of this total value, $895,524 was received for gas supplied for domestic consumption, and the value of the gas consumed for industrial purposes is estimated at $1,224,424.

The table of the distribution of gas in 1913 by States shows that the larger portion of the gas consumed in Louisiana and Alabama was utilized for industrial purposes, and that of the gas consumed for industrial purposes the larger part was consumed for power. In Shreveport gas was consumed in 1913 for manufacturing purposes by two glass factories, and also by a stave company, a handle company, and a silo company. For power gas is consumed in Louisiana by cotton gins, cottonseed mills, ice companies, by engines and boilers in the oil and gas fields of the State in the operation of wells, by drilling contractors, and by oil refineries.

The total number of productive gas wells in Louisiana at the close of 1913 was 190, of which 53 were completed during that year. The number of dry holes drilled in 1913 was 24 and the number of wells abandoned was 18.

In the following table is given the record of the natural-gas industry in Louisiana from 1909 to 1913, inclusive:

Record of natural-gas industry in Louisiana, 1909–1913.

Year.	Number of producers.	Number of consumers.		Total value of gas produced.[a]	Wells.		
		Domestic.	Industrial.		Drilled.		Productive Dec. 31.
					Gas.	Dry.	
1909	11	4,034	164	$326,245	26	10	70
1910	21	8,547	320	509,408	23	4	91
1911	27	[b] 17,964	442	858,145	36	18	116
1912	41	[b] 31,105	528	1,747,379	50	20	155
1913	57	[b] 33,424	604	2,119,948	53	24	190

[a] Includes the production of Alabama.

[b] Includes consumers supplied with gas piped from Louisiana to Arkansas and Texas.

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TEXAS.

The year 1913 was one of unusual activity in the natural-gas interests of Texas. The completion of new wells and the extension of pipe lines to supply the product to consumers combined to increase the value of the gas consumed in the State from $1,405,077 in 1912 to $2,073,823 in 1913, a gain of $668,746, or nearly 50 per cent, making this the most prosperous year in the history of the natural-gas industry in this State. The consumption of gas increased from 7,470,373,000 cubic feet in 1912 to 12,159,755,000 cubic feet in 1913. The average price of gas per thousand cubic feet in 1913 was 17.05 cents, as compared with 18.81 cents in 1912. This reduction in average price was largely due to the greater gain in quantity of gas supplied for industrial use over that of the year 1912, as compared with the increase in domestic consumption in 1913. The average price received for gas per thousand cubic feet supplied for domestic purposes in 1913 was 38.3 cents; it was 38.7 cents in 1912. The average price received for gas supplied for industrial purposes in 1913 was 8.95 cents per thousand cubic feet; in 1912 it was 9.72 cents.

The chief gas-producing district of Texas is located in Clay County, where there were 33 gas wells at the close of 1913. The gas companies operating in this field are the Henrietta Oil & Gas Co., the Developers Oil & Gas Co., the Wichita Falls Gas Co., and the Lone Star Gas Co. The last-named company supplies gas to consumers through the following-named companies: County Gas Co., Dallas Gas Co., Fort Worth Gas Co., Gainesville Gas & Electric Co., and North Texas Gas Co. The following cities and towns in Texas are supplied with gas from Clay County wells: Henrietta, Dallas, Fort Worth, Gainesville, Eagle Ford, Grand Prairie, Dalworth Park, Arlington, Byers, Petrolia, Wichita Falls, Bellevue, Bowie, Sunset, Alvord, Decatur, Rhome, Bridgeport, Irving, Denison, Denton, Sherman, and Whitesboro.

The next gas field in importance seems to be the Mexia field of Limestone County, which was opened in 1912 and is rapidly coming to the front as a gas producer. At the close of 1913 three companies were operating in this field—the Little Giant Oil & Gas Co., the Mexia Oil & Gas Co., and the Southern Oil & Gas Co.—with a total of 17 gas wells, of which all but 1 were drilled in 1913. The wells vary in depth from 550 to 800 feet and have an average pressure of 275 pounds and a large volume. The towns of Mexia and Teague were supplied with gas from this field in 1913 for both domestic and industrial purposes, the gas consumed for industrial purposes being utilized by cotton gins, cottonseed mills, broom factory, laundries, electric-light plants, etc., besides a large consumption in the field. It is reported that the surplus gas from wells in this field will be supplied to consumers in Waco.

Gas from wells in Webb County is supplied to consumers in Laredo by the Border Gas Co. Moran and Albany are supplied with gas from wells in Shackelford County. Navarro County wells are still supplying gas to consumers in Corsicana.

Some important developments were in progress in Brown County in 1913. At the close of that year there were four good gas wells in this field; but very little of the product was consumed in 1913 except for field purposes. The town of Bangs was piped for gas in 1913 and consumers were being supplied with gas from this field early in 1914.

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It is reported that Brownwood will also be supplied with gas from this field.

It is reported that gas produced from wells in Coleman County will be supplied to consumers in Santa Anna, which town was being piped early in 1914.

Gas was also produced and used from wells located in Atascosa, Bexar, Eastland, Goliad, Gonzales, Hardin, Harris, McMullen, Liberty, Throckmorton, and Wichita counties in 1913.

It may be of interest in this connection to refer to a "gushing" well (gas geyser) in Texas. This well is located on the ranch of Mr. C. R. Byrne, 8½ miles east of Tilden, in McMullen County. The well was completed June 24, 1908, and has been open ever since, yet the gas seems to increase. No measurements of yield or pressure have been made, but when ignited no wind has ever extinguished it. For the first year or so the gushes were 8 days apart; then as the sand was thrown out the time between gushes gradually diminished, and now it gushes every 22 to 24 hours. The only attempt to cap this well was made by an experienced oil and gas driller and three minutes was the longest time he would risk keeping it closed. This was between gushes during the regular flow. In three minutes' time enough gas accumulated to force all water down in the casing and it was believed this would force the casing out if kept closed longer. The gas pressure during gushes is much greater than during the regular flow. As the gushes are uncontrolled, the gas from this well can not be used.

The following is the log of this well:

Log of gushing gas well (gas geyser) near Tilden, McMullen County, Tex.

	Feet.
Top, black surface soil	25
Sand rock	25 to 110
Water sand with layers of sand rock—fresh sulphur water	110 to 175
Hard sand rock	175 to 185
Soapstone	185 to 327
Hard sand rock	327 to 330
Water sand, 50 gallons per minute flow, very salt water	330 to 360
Soapstone	360 to 409
Hard shell rock	409 to 410
Green sand showing some oil, but could not test, on account of caving	410 to 445
Soapstone, shale, and mixture of lignite	445 to 680
Sand rock	680 to 694
Water sand, 150 gallons per minute flow; warm mineral and salt water	694 to 734
Very hard rock. As the drill apparently went through into a cavity the gas came with such force that hose could not stand the pressure. The force of this gas threw water and an immense quantity of sand 150 feet high. The casing from surface to the 680-foot rock is 4¼ inches. The hole through the 14-foot rock was reduced to 3½ inches and about 2 feet of the hole in the 734-foot rock (two days' drilling) was done with 3½-inch bit; but this rock was so hard the remaining 5 feet through that bottom rock was bored with a 2-inch bit	734 to 741

A considerable quantity of gas is produced from wells in Louisiana and piped to Texas for consumption, the number of consumers and the value of the gas consumed being included in the statistics for the State of Louisiana, which will be found in another part of this report.

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The cities and towns supplied in Texas with gas from this source in 1913 were as follows: Atlanta, Bloomburg, Cass, Leigh, Marshall, Queen City, and Texarkana.

In the following table is given a record of the natural-gas industry in Texas from 1909 to 1913, inclusive:

Record of natural-gas industry in Texas, 1909–1913.

Year.	Number of producers.	Number of consumers.		Total value of gas produced.	Wells.		
		Domestic.	Industrial.		Drilled.		Productive Dec. 31.
					Gas.	Dry.	
1909	17	5,035	130	$127,008	7	6	28
1910	19	14,719	133	447,275	22	5	52
1911	29	22,972	303	1,014,945	19	14	69
1912	41	27,226	329	1,405,077	24	23	87
1913	50	37,350	393	2,073,823	43	29	123

CALIFORNIA.

The year 1913 may be considered a memorable one in the history of the natural-gas industry of California.

Since the discovery of gas in the Buena Vista Hills, near Taft, in Kern County, the natural-gas industry of California has continued to improve, and the year 1913 added an important chapter to its history by the completion of the pipe line from the Midway field to southern California and the introduction of natural gas into Los Angeles and towns and cities in the adjacent territory. The construction of this line by the Midway Gas Co., which was described in the report of this series for 1912, was successfully accomplished after many difficulties and at great expense. The Midway Gas Co. is the pipe-line company and the Southern California Gas Co. the distributing company, which purchases the gas from the producers in the field. The gas piped through this line in 1913 was produced from wells located in the Buena Vista Hills and operated by the Honolulu Consolidated Oil Co. and the Kern Trading & Oil Co. The gas is delivered at West Glendale terminus outside the city of Los Angeles by the Southern California Gas Co., which supplies gas directly to consumers in the city of Los Angeles and to consumers outside of the city limits of Los Angeles, in the cities of Glendale, Vernon, Torrance, Compton, Athens, Gardena, Cudahy, Lynwood, Moneta, Eagle Rock, Tropico, Burbank, San Fernando, and Redondo Beach. The Southern California Gas Co. also sells gas to the Southern California Edison Co., which is supplying Long Beach, and to the Western Fuel & Power Co., which is supplying Venice, Santa Monica, and Sawtelle. Gas is also sold by the Southern California Gas Co. to the Los Angeles Gas & Electric Corporation, which serves consumers in the city of Los Angeles and consumers outside of Los Angeles in the cities of Pasadena, South Pasadena, Vernon, Eagle Rock, Huntington Park, Alhambra, and San Gabriel. Approximately 116,000 consumers were being supplied with natural gas in the city of Los Angeles at the close of the year 1913, and probably

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30,000 consumers were being served outside of the city limits. Doubtless artificial gas in southern California will eventually be displaced by natural gas. The rate as fixed by the city council for gas in the city of Los Angeles from July 1, 1913, to July 1, 1914, was 70 cents per thousand cubic feet. The first gas supplied by the Southern California Gas Co. for consumption was in April, 1913.

It is estimated that 11,034,597,000 cubic feet of gas, valued at $1,883,450, or 17.07 cents per thousand cubic feet, was produced in this State and consumed in 1913, as compared with 9,354,428,000 cubic feet, valued at $1,134,456, or 12.13 cents per thousand cubic feet, in 1912. This increase was brought about both by the introduction of gas into southern California and also by an increased production and more general use of gas in other fields of the State.

The wells with greatest capacity and highest pressure are located in Kern County, where at the close of 1913 there were 27 gas wells, 7 of which were completed in 1913. These wells range in depth from 1,600 to 2,782 feet and have a pressure of from 250 to 960 pounds. The towns of Bakersfield, Fellows, Taft, South Taft, and Maricopa are supplied with gas from this field in addition to large quantities of gas consumed for drilling and pumping throughout the oil fields.

Considerable gas is produced from the oil wells of Orange and Santa Barbara counties, where it is largely used for field purposes, and as this gas is very rich in gasoline, several plants have been installed in these counties for the production of gasoline, which has become an important industry of this State. Some gas produced in the Santa Maria field of Santa Barbara County is supplied for domestic purposes to the towns of Santa Maria, Arroyo Grande, Nipomo, Guadalupe, Los Berros, and Betteravia.

The table of the distribution of natural gas in 1913 by States shows that 164,358 domestic consumers were supplied with gas in California at the close of 1913, the quantity of gas consumed for domestic purposes in 1913 being estimated at 1,632,337,000 cubic feet, valued at $1,100,702, or 67.43 cents per thousand cubic feet, as compared with 18,171 domestic consumers supplied at the close of 1912, and a domestic consumption of 974,796,000 cubic feet of gas, valued at $525,428, or 53.9 cents per thousand cubic feet, in 1912. It also appears that large quantities of gas are consumed in this State for power, the estimate for 1913 being 9,402,260,000 cubic feet, valued at $782,748, or 8.33 cents per thousand cubic feet. As has already been stated in previous reports large quantities of gas, for which there is no use, are wasted in the oil fields of California. The establishment of gasoline plants in the fields where the gas is rich in gasoline, is one of the means of utilizing this waste or excess gas. A report of the statistics of gasoline production in 1913 will be found in another part of this report.

The names of the counties in California in which gas was produced and used for either domestic or power purposes in 1913 are as follows: Humboldt, Kern, Orange, Los Angeles, Sacramento, San Joaquin, Santa Barbara, Santa Clara, Solano, Tehama, Ventura, and Fresno.

The number of productive gas wells in this State at the close of 1913 was 72, of which 13 were drilled in 1913, 9 of which were productive and 4 were dry holes. The number of wells abandoned in 1913 was 8.

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In the following table is given a record of the natural-gas industry in California from 1909 to 1913, inclusive:

Record of natural-gas industry in California, 1909–1913.

Year.	Number of producers.	Number of consumers.		Total value of gas produced.	Wells.		
		Domestic.	Industrial.		Drilled.		Productive Dec. 31.
					Gas.	Dry.	
1909	35	7,612	104	$446,933	7	.....	[a] 64
1910	30	8,292	217	476,697	3	2	[a] 65
1911	32	10,598	307	800,714	8	6	[a] 66
1912	43	18,171	232	1,134,456	6	1	[a] 71
1913	48	[b] 164,358	141	1,883,450	9	4	[a] 72

[a] Includes some artesian wells from which gas was used.
[b] Includes some consumers who are using mixed gas.

ARKANSAS.

The natural-gas situation in Arkansas was practically the same in 1913 as in 1912. The productive gas fields of this State are located in Sebastian and Scott counties, where there was at the close of 1913 a total of 98 productive gas wells, 3 of which were drilled in 1913. The completion of new wells in 1913 in Sebastian County extended the field 1 mile west of former limits. The gas sand is found 200 feet deeper in the new wells. The gas in this field is produced from close, hard, gray sand.

The depth of wells in Arkansas varies from 900 to 2,350 feet. The gas-bearing sands of Sebastian County are found between 1,200 and 1,400 feet and between 2,000 and 2,400 feet. Pressure varies from 21 to 200 pounds in old wells, and reaches 315 pounds in new wells. Wells in Sebastian County with an initial average rock pressure in 1907 of 210 pounds have now an average rock pressure of 42 pounds. One well in steady service for 10 years still shows a rock pressure of over 200 pounds. The wells of the field may be said to be holding up well.

The number of domestic consumers supplied with gas in 1913 was 5,836, as compared with 5,601 in 1912, while the number of industrial consumers decreased from 16 in 1912 to 11 in 1913. The gas used in this State for manufacturing purposes is consumed by brick works.

In an effort to find gas in Bradley County, Ark., in 1913, the Vick Oil & Gas Co. drilled near Vick to a depth of 2,638 feet, but was unsuccessful, the well being a dry hole.

Reference to the natural-gas statistics of Louisiana will show that gas is piped from the Caddo field of that State and supplied to consumers in many cities and towns in Arkansas, the figures of this gas consumption being included with those of Louisiana.

The statistics of the natural-gas industry of Arkansas are included with those of Colorado and Wyoming.

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COLORADO.

Reports received from gas producers in Colorado indicate that the quantity and value of gas consumed in 1913 was less than in 1912. This State had at the close of 1912 a total of 8 productive gas wells and only 5 at the close of 1913.

The gas consumed in Colorado in domestic use is chiefly produced from one well located near Boulder, Boulder County, the product of which is supplied to consumers in Boulder. Considerable gas is produced from the oil wells in the Boulder oil field of this State. It is used for operating purposes in the field. The gas produced from the oil wells in this field is rich in gasoline, and two plants have been erected and are in operation for the extraction of gasoline from the surplus gas. The Florence oil field of this State also produces gas which is used under boilers in the field. The gas derived from the oil wells of this State and consumed for field purposes—under boilers, for gas engines, and for the extraction of gasoline—is not metered; and, therefore, the quantity and value of it can only be estimated.

Las Animas County has two gas wells, the product of which is consumed by the owners of the ranches upon which they are located. One of these wells is 16 years old, and the flow of gas has remained about the same for years.

Two gas wells have been drilled in Mesa County, one of which has been furnishing gas for the domestic use of the owner for eight years. The gas is not metered, and an abundance is going to waste. Another well in this county, called the "spouting" well, an account of which was given in the report for 1912, shows no diminution, but rather seems to be increasing its production of gas and water. The Grand River Oil & Gas Co. was drilling a well in 1913 1¼ miles west of De Beque, and had a good showing of oil and gas, but not yet in commercial quantities.

The statistics of the natural-gas industry in Colorado are included with those of Arkansas and Wyoming.

IOWA.

There has been no change in the natural-gas situation in Iowa since the last report. There are six shallow wells located in Louisa County from which sufficient gas is obtained to supply three families with lights and partly for cooking. The wells have a depth of from 100 to 120 feet and a gas pressure of about 5 to 7 pounds.

In Guthrie County attempts have been made in past years to find gas in three wells, which remain undeveloped; the wells were drilled to a depth of 55 to 125 feet. Two of them located 1½ miles from the town of Bayard had a heavy flow of gas, with a flame from 12 to 14 feet high. This gas was allowed to escape for six months, and then the wells were plugged. The other well is located west of Herndon and is said to have had very high pressure.

MICHIGAN.

There is no change in the natural-gas situation in Michigan since the last report. At the close of 1913 there were 18 shallow wells in this State producing both gas and water, from which gas was being

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used for domestic consumption; and each of these wells was supplying one family, except two wells which supplied two families each. A small quantity of gas produced from oil wells was consumed for operating purposes.

No gas wells were drilled in 1913, and one well was abandoned. The small quantity of gas which was consumed was produced in the following-named counties: Benzie, Macomb, Oakland, St. Clair, Washtenaw, and Wayne. The total value of the gas produced from wells and consumed in this State in 1913 is estimated at $1,405.

MONTANA.

Although there are no statistics of gas production in Montana, it may be of interest to report a gas well completed in this State in 1913 jointly by the Consolidated Oil & Gas Co. and the Mid-West Oil Co. The well is located in Dawson County and has a depth of 2,345 feet. The first gas was encountered at a depth of 840 feet, and two more light flows have been found lower down. The gas has no odor. It is estimated by the drillers that the flow would exceed 1,000,000 cubic feet a day. The gas is used under boilers.

NORTH DAKOTA.

The natural-gas production of North Dakota is of little importance. Although gas has been found and used from shallow wells in Bottineau and Renville counties and from artesian wells in Lamoure County, the only gas used commercially in 1913 was in the town of Lansford, the gas being utilized entirely for domestic purposes.

The wells in Bottineau and Renville counties range in depth from 170 to 325 feet and have a gas pressure of from 25 to 105 pounds. At the close of 1913 there were 17 wells in this State from which gas was being used, 7 having been abandoned during the year.

The statistics of the production of natural gas in this State are included with those of South Dakota.

SOUTH DAKOTA.

No new developments have been reported in the natural-gas districts of South Dakota for 1913. The gas in this State is produced from artesian wells located in the following-named counties: Hughes, Potter, Stanley, Sully, and Walworth. With the exception of the cities of Pierre and Fort Pierre, where gas is used commercially, the gas is produced and used from individual wells by the owners. Some of these producers state that their wells are producing far more gas than they can use; others report that their gas is growing weaker and that windmills are now coming into use in place of the gas for pumping water. In the cities of Pierre and Fort Pierre the gas is consumed for both domestic and power purposes. Over 350 domestic consumers are supplied with gas in these towns, besides gas used at the electric-light and water plants.

At the close of 1913 there were 35 artesian wells from which gas was used, there being no change in number since the last report.

The statistics of the natural-gas industry in this State are included with those of North Dakota.

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WYOMING.

Although there was considerable activity in the oil and gas fields of Wyoming in 1913 as compared with 1912, the returns received from gas producers show a reduction in quantity and value of gas consumed. The principal gas production is from wells located in Bighorn County, which supply domestic consumers in the towns of Basin, Greybull, and Byron. The number of gas wells in Bighorn County at the close of 1913 was 15, of which 3 were drilled in 1913, 2 by the Greybull Oil Co. and 1 by the Utah-Wyoming Consolidated Oil Co. It is reported that since January 1, 1914, a well was completed by the Montana & Wyoming Oil Co., with an estimated daily capacity of 4,000,000 cubic feet of gas. This well is located three-fourths of a mile north of the oil wells at Byron and will be used by the company for fuel for drilling other wells and for supplying power to pump their own oil wells. The gas wells of this county vary from 450 to 2,250 feet in depth. Some of the older wells used in this field are almost exhausted; but new wells have a pressure of from 145 to 650 pounds.

Very little gas was produced and consumed from the wells of Converse County in 1913. Considerable gas, which is used for field purposes, is produced from the oil wells in Natrona County. It is reported that some of the flowing oil wells in this field are estimated to produce as much as 1,500,000 cubic feet of gas each 24 hours. In Park County 4 gas wells have been completed, one of which was drilled in 1913 by the Enalpac Oil & Gas Co. Two wells in this county have an estimated capacity of 6,500,000 and 9,000,000 cubic feet of gas each 24 hours. As there is no market for the gas, the wells are shut in. The wells of this county have a depth of from 600 to 1,500 feet and a pressure of from 430 to 455 pounds. Gas produced from oil wells in the Uinta County oil field is used to some extent for operation of gas engines in the oil field.

The statistics of the natural-gas industry in Wyoming are included with those of Arkansas and Colorado.

IMPORTS.

The imports of natural gas for consumption during the last six years have been as follows:

Value of natural gas imported for consumption, 1908–1913.

1908	$22,003	1911	None reported.
1909	6,060	1912	Do.
1910	None reported.	1913	Do.

No exports of natural gas from 1908 to 1913, inclusive, were reported.

NATURAL GAS IN FOREIGN COUNTRIES.

CANADA.

The preliminary report on the mineral production of Canada for 1913, published by the department of mines, states:

There was comparatively little change in the production of natural gas in Ontario, but a large increase in the production in New Brunswick and in Alberta. The total production in 1913 was approximately 20,345,000,000 feet, valued at $3,338,314, of which 828,000,000 feet, valued at $174,006, was from New Brunswick; 12,487,000,000

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feet, valued at $2,092,400, from Ontario, and 7,030,000,000, valued at $1,071,908, from Alberta.

The production in 1912 was reported as 15,287,000,000 feet, valued at $2,362,700, and included 174,000,000 feet from New Brunswick, valued at $36,549; 12,529,000,000 feet from Ontario, valued at $2,036,245; and 2,584,000,000 feet from Alberta, valued at $289,906.

These values represent as closely as can be ascertained the value received by the owners or operators of the wells for gas produced and sold or used. The values do not represent what consumers have to pay, since in cases where transmission is by separately operated pipe-line companies such cost is not included.

The following table gives the value of natural gas produced in Canada each year since 1909, by Provinces:

Value of natural gas produced in Canada, by Provinces, 1909–1913.

Year.	New Brunswick.	Alberta.	Ontario.	Total Canada.
1909	.....	$61,722	$1,145,307	$1,207,029
1910	.....	75,168	1,271,303	1,346,471
1911	.....	110,165	1,807,513	1,917,678
1912	$36,549	289,906	2,036,245	2,362,700
1913	174,006	1,071,908	2,092,400	3,338,314

The following table gives the statistics of natural-gas production in the Province of Ontario, Canada, since 1909:

Statistics of natural-gas production in the Province of Ontario, Canada, 1909–1913.

Year.	Wells bored in the year.		Producing wells.	Miles of gas pipe.	Workmen employed.	Gas production.		Wages for labor.
	Productive.	Non-productive.				Quantity (cubic feet).	Value.	
1909	.....	.....	744	987	171	5,388,000,000	$1,145,307	$103,672
1910	.....	.....	828	982	186	7,263,427,000	1,271,303	118,785
1911	268	38	1,179	1,296	287	10,863,871,000	1,807,513	153,683
1912	178	41	1,247	1,448	277	12,529,463,000	2,036,245	184,351
1913	166	48	1,522	1,720	402	12,416,264,000	2,337,000	289,490

Consul General Frank Dillingham, of Winnipeg, Canada, under date of May 5, 1914, says:

According to newspaper reports, natural gas has been found on a farm a few miles west of the town of Dauphin, Manitoba, which is situated about 178 miles northwest of Winnipeg. It is reported that the gas has been burning with the flame 6 feet above the ground for several days.

HUNGARY.

Consul General William Coffin, of Budapest, under date of April 4, 1914, says:

The first actual progress in the utilization of the natural gas of Kissarmas, Hungary, has been registered by the completion and ceremonial delivery to the county authorities of a pipe line from Kissarmas to Marosujvar, a distance of about 30 miles. This pipe line was laid down entirely by Hungarian engineers and workmen and cost a little over a half million dollars. The materials used were entirely of Hungarian manufacture and the time consumed in construction was just one year. This is said to be the only pipe line of importance at present in Europe for conveying natural gas. Since its construction was begun, gas has been discovered in other parts of Hungary, and there is every indication that before many years natural gas will come into general use in Hungary.

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This large store of natural gas, which until a few years ago was not known to exist, will be the means of stimulating every branch of industry in Transylvania and even in more distant parts of Hungary. It is said that several companies have already begun to erect manufacturing plants in the neighborhood of the gas fields. A full account of the Transylvania natural-gas fields of Hungary was given in the report for the year 1912.

Another communication from Mr. Coffin, under date of July 24, 1914, says:

A deposit of natural gas has been discovered in the township of Temerin, in the southern part of Bacska County, Hungary. This is the third district in Hungary in which natural gas has been discovered, and there are evidences that it exists in other parts of the country, and that the deposits are enormous. A law enacted in 1911 makes all natural gas deposits discovered in Hungary the property of the Government, and any exploitation of them must be made with the permission and under the authority of the minister of finance. Landowners, on whose lands gas has been discovered, or may be discovered in the future, are entitled to a certain compensation from the Hungarian Government.

An article by Mr. E. Czako, of Karlsruhe, Germany, on the Transylvania and Kissarmas natural-gas fields of Hungary, states that from January 30, 1909, when the first natural-gas (methane) well was discovered in Kissarmas, Kolozs County, little was known of the incident until November, 1911, when another gas well was drilled, which had the proportions of a catastrophe. The subject of natural gas was a new one for all of Europe, and the circle of experts of the Hungarian Government had to exercise much patience and industry to cope with this difficult problem, which involved the drilling of an extraordinarily powerful natural-gas well in 1911 and its utilization for the benefit of industry and of the country—all within a period of three years. With the successful closing of the gas wells, after much trouble, at the end of July, 1912, the work came to an end. The results of these three years' work appeared in a report on the investigations up to date of the occurrence of natural gas in the Transylvania basin.[1] This report states that aside from the gas wells that have become known in drilling artesian wells in the great Hungarian plain and those which were partly used for illumination or power, only locally, to be sure, on account of the small yield of the wells, smaller seepages of natural gas have also been known in Transylvania, but for many years have remained practically uninvestigated. However, since the discovery of natural gas at Kissarmas they have been subject to a thorough geological investigation. These two gas regions have no connection with each other. The gases in the great Hungarian basin are derived from great bogs of earlier periods and are connected with the decomposition (in the absence of air) of the fossil plants, but the natural gas of Transylvania, according to all appearances, is connected with petroleum, which latter, having marine origin, is also closely connected with the occurrence of salt. The natural gas of Neuengamer, in all probability, has a similar origin.

The Kissarmas natural-gas field owes its discovery to the fact that the Hungarian Government had been looking for potassium salts since the year 1907 in the Transylvania Tertiary basin below the salt deposits underlying the former lower Hungarian sea bottom, and had

[1] Published by Royal Hungarian Minister of Finance, Budapest, 1911.

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made systematic borings for them. These borings had not produced the results desired, but the great gas wells of Kissarmas were discovered.

The first well was begun in February, 1908, at Nagysarmas. Many difficulties were encountered. At a depth of about 2,000 feet the work had to cease on account of the caving of the well after one drill had been broken and the boring rod damaged three times. This well yielded salt at various depths in considerable quantity, but only the very smallest quantity of gas.

The second well was begun on November 26, 1908, in the neighborhood of Kissarmas, and at 70 feet combustible gases blew out with the salt water. At 350 feet the gas blew out and set the derrick on fire. After 10 hours' work the gas flame was extinguished by throwing on earth. The deeper the drilling the stronger became the gas, causing great difficulties in the drilling operations, particularly in lengthening the drilling rod. On January 30, 1909, at a depth of 1,300 feet, the gas blew out with such force that the mud pipes were torn away and salt water of 7° B. was blown out to a height of 50 feet. Drilling was stopped in order to make necessary changes in the method of drilling and to take care of the gas pressure. Drilling was continued on March 25. During the intermission Prof. J. Pfeifer investigated the gas well. Between February 16 and February 18, 1909, he determined the composition of the gas, which came from a depth of 650 feet, to be 99.25 per cent methane and 0.75 per cent nitrogen, the gas being almost pure methane. The heating value of the gas in a Junkers calorimeter showed 8,600 calories. The yield per hour by anemometer measurements was determined to be 3,793 cubic meters, and the gas pressure at that time was estimated to be 30 atmospheres. A later analysis made by Professor Doctor Schelle gave the following results:

	Per cent.
Methane	99.0
Hydrogen	0.4
Oxygen	0.4
Nitrogen	0.2

Carbon dioxide, ethylene, and carbon monoxide not present.

The gas from Kissarmas is, therefore, the purest natural gas thus far known in the world.

Drilling was continued and the quantity of gas and the pressure steadily increased, but on account of the great difficultues and danger the drilling contractors did not wish to continue the work further. On April 22, 1909, at a depth of 302 meters, drilling was stopped without having reached the potassium salts, which were supposed to be found at a greater depth. The gas was escaping with a deafening roar, audible for several kilometers, and was so strong that the heaviest tools held over the mouth of the well were blown away with ease. In contrast to the first drilling, this well only yielded salt water at first. Since the middle of February, 1909, the gas has come out dry from the well.

After the completion of the second well the Government became interested in this new question. First of all, the gas well must be closed in order to make economic use of it; second, a geologic investigation was necessary to get some reliable data as to the possible duration and yield of gas. It also became necessary to establish

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new mining laws to govern present conditions, as the laws in force had received little attention because petroleum and its products were of little importance when the laws were made. An addition was made to the mining laws January 17, 1911, in which petroleum, naphtha, asphalt, paraffin wax, etc., were declared to belong to the Government. The Government has also established a monopoly of the natural gas in the land.

ITALY.

The Rivista del Servizio Minerario gives the production and value of natural gas in Italy from 1909 to 1913, as follows:

Production and value of natural gas in Italy, 1909–1913.

Year.	Quantity (cubic meters).	Value.
1909	8,268,000	$42,287
1910	8,840,000	73,301
1911	9,021,000	74,174
1912	6,800,000	57,128
1913	(a)	(a)

[a] Not available.

UNITED KINGDOM.

The annual report of the British home office gives the statistics of the production and value of natural gas in the United Kingdom for the years 1909 to 1913 as follows:

Production and value of natural gas at Heathfield,[a] England, 1909–1913.

Year.	Quantity.	Value.
	Cubic feet.	
1909	236,800	(b)
1910	262,000	(b)
1911	221,400	(b)
1912	161,200	(b)
1913	87,450	(b)

[a] Heathfield in Sussex County. [b] Not stated.

COMPOSITION OF NATURAL GAS FROM VARIOUS SOURCES.

The following tables give analyses of natural gas from different localities in the United States and foreign countries:

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Composition of natural gas in the principal producing regions.

State and district.	Collected from—	Constituents.						Specific gravity (air=1).	Heating value, calculated, per cubic foot.	Analyst.	Where published.	Remarks.
		Methane, marsh gas (CH_4).	Ethane (C_2H_6).	Carbon dioxide (CO_2).	Nitrogen (N).	Oxygen (O).	Other constituents.					
ALABAMA.												
Fayette County:		*Per cent.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Per cent.*		*B. t. u.*			
Fayette	Well	98.30	.....	0.30	1.30	0.10	.....	.....	.....	G. A. Burrell	U. S. Geol. Survey Mineral Resources, 1911.	Collected by D. T. Day, July, 1910.
ARKANSAS.												
Sebastian County:												
Fort Smith	Wells of Southwestern General Gas Co.	96.12	.....	.93	2.71	.13	H 0.01; CO .08; C_2H_4 .02	.....	a 966.0	.....	Unpublished	
Do	Wells of Mansfield Gas Co.	92.40	.....	.42	3.38	.30	H 2.70; CO .50; C_2H_4 .30	.....	a 923.0	H. E. Manning	....do	Analysis made Oct. 31, 1905.
CALIFORNIA.												
Contra Costa County	Wells on Miner ranch, California Gas & Electric Co.	93.00	.....	.40	3.30	.....	H 3.30	0.558	.....	A. Auchie Cunningham.	U. S. Geol. Survey Bull. 340, p. 342, 1908.	Collected 1904.
Do	....do	92.30	.....	.....	.....	.....	H 7.50	.....	.....	....do	....do	Loss in sampling, etc., 2 per cent; collected 1907.
Fresno County:												
Coalinga field	Several wells, Kern Trading & Oil Co.	88.00	.....	11.10	.90	.....	.....	.....	937.0	G. A. Burrell	Bur. Mines Bull. '19, p. 56.	Collected by G. H Salisbury, June 10, 1910.
Kern County:												
Buena Vista Hills	Well	79.95	11.27	4.88	3.69	.21	.....	.651	1,060.9	W. P. Thompson, analyst; H. H. Craver, chemist.	Unpublished	Received from Hope Engineering & Supply Co.; tested at Pittsburgh Testing Laboratory.
Kern River field	Reed 1A well, Associated Oil Co.	84.30	8.00	6.50	1.20	.....	.....	.....	1,047.0	G. A. Burrell	Bur. Mines Bull. 19, p. 56.	Collected by C. Ballah, Nov. 24, 1909.

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King County:												
Sunset field	Well No. 1, Crandall.	87.70	.....	10.50	1.80	.....	.....	.....	934.0	.....do.....	.....do.....	Collected by Irving C. Allen, July 14, 1909.
McKittrick field	Several wells, Dabney.	66.20	1.00	30.40	2.40	.....	.....	.....	724.0	.....do.....	.....do.....	Collected by Irving C. Allen, Sept. 6, 1909.
Los Angeles County:												
West Los Angeles	Well No. 1, Pacific Petroleum Co.	91.00	2.70	1.00	5.20	.10	.....	.....	1,019.0	.....do.....	.....do.....	Collected by Irving C. Allen, July 23, 1909.
Los Angeles	Gas-producing oil well.	83.70	.....	6.68	6.31	2.86	CO .25 C_2H_4 .20	.....	.....	Hamilton P. Cady and David F. McFarland.	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Collected by Charles R. Fletcher.
Napa County:												
Mount Helena	Cracks in rocks, Phoenix mine.	61.49	.....	.74	31.44	6.33	.....	.....	.....	Dr. Melville.....	U. S. Geol. Survey Mon. 13, p. 373, 1888.	Depth 150 to 300 feet.
Orange County:												
Fullerton field	Several wells, C. V. Hall.	86.70	9.50	1.70	2.10	.....	.....	.....	1,100.0	G. A. Burrell.....	Bur. Mines Bull. 19, p. 56.	Collected by Irving C. Allen, July 22, 1909.
Do	Well No. 52, Petroleum Development Co.	85.80	10.90	1.40	1.90	.....	.....	.....	1,117.0	.....do.....	.....do.....	Collected by J. Collins, Nov. 17, 1909.
San Joaquin County:												
Stockton	Well No. 2.....	60.47	.....	Tr.	26.66	1.00	CO Trace. H 11.87	.612	.....	Price & Son, San Francisco.	California State Min. Bur. Bull. 3, p. 75.	
Do	Well No. 5.....	62.93	.....	.50	24.36	.70	CO Trace. H 11.51	.607	.....	.....do.....	.....do.....	
Do	Stockton Natural Gas Co.	83.00	.....	.05	.....	.06	CO Trace. H .06	.....	.....	.....	U. S. Geol. Survey Mineral Resources, 1888.	Air introduced in sampling, etc., 16.83 per cent.
Do	Western States Gas & Electric Co.	50.60	.....	.30	18.30	1.00	CO 1.00 H 26.70 Illu. 2.10	.....	680.2	Superintendent of company.	Unpublished.....	
Santa Barbara County:												
Santa Maria field	Several wells.....	62.70	20.20	15.50	1.40	.20	.....	.....	1,044.0	G. A. Burrell.....	Bur. Mines Bull. 19, p. 56.	Collected by Irving C. Allen, Aug. 5, 1909.
Do	Well No. 5, Santa Maria Oil & Gas Co.	64.60	19.00	14.10	2.10	.20	.....	.....	1,042.0	.....do.....	.....do.....	Collected by W. W. Bradbury, Nov. 11, 1909.
Ventura County:												
Torrey field	Several wells, Torrey.	54.20	35.60	6.80	3.40	.....	.....	.....	1,240.0	.....do.....	.....do.....	Collected by B. B. Grinnell, Feb. 18, 1910.
ILLINOIS.												
Bureau County:												
Princeton	Well.....	13.97	.....	.10	85.83	.05	CO 0.05	.....	.....	Dr. Rollin Chamberlin.	Kansas Univ. Geol. Survey, vol. 9, 1908.	Analyzed, 1907.
Pike County:												
Pittsfield	.....do.....	73.81	.....	.81	21.92	3.46	.....	.....	.....	.....	Illinois Geol. Survey Bull. 2, p. 82.	

a Whether gross or net unknown.

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Composition of natural gas in the principal producing regions—Continued.

State and district.	Collected from—	Constituents.						Specific gravity (air=1).	Heating value, calculated, per cubic foot.	Analyst.	Where published.	Remarks.
		Methane, marsh gas (CH_4).	Ethane (C_2H_6).	Carbon dioxide (CO_2).	Nitrogen (N).	Oxygen (O).	Other constituents.					
INDIANA.												
Delaware County:		*Per cent.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Per cent.*		*B. t. u.*			
Muncie	Wells Nos. 1, 2, 3, 4, and 6.	92.67	0.25	0.25	3.53	0.35	H 2.35 H_2S .15 CO .45	.....	.....	Prof. H. C. Howard.	U. S. Geol. Survey Eighth Ann. Report, p. 592, 1889.	
Grant County:												
Marion	Well No. 3	93.58	.15	.90	3.42	.55	H 1.20 HS .20 CO .60	.....	.....	.....do.....	.....do.....	
Do	Well	77.40	14.18	.73	6.66	.....	He .17 C_2H_4 .86	.....	.....	Hamilton P. Cady and David F. McFarland.	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Collected by B. A. Kinney, Aug. 25, 1906.
Howard County:												
Kokomo	Wells Nos. 1 and 2	94.16	.30	.29	2.80	.30	H .18 HS .18 CO .55	.....	.....	Prof. H. C. Howard.	U. S. Geol. Survey Eighth Ann. Rept., p. 592, 1889.	
Do	Well	93.60	.....	.40	6.00	.....	.....	.....	.....	F. C. Phillips	Am. Chem. Jour., vol. 16, p. 416, 1894.	Collected by E. C. Somers.
Madison County:												
Anderson	McCullough well	93.07	.49	.26	3.02	.42	H 1.86 HS .15 CO .73	.....	.....	Prof. H. C. Howard.	U. S. Geol. Survey Eighth Ann. Rept., p. 592, 1889.	
IOWA.												
Dallas County	Wells in drift at Dawson.	.....	.....	1.60	.....	.55	CO 2.50 Hydrocarbon and N. 95.35	.....	.....	.....	Iowa Geol. Survey Eighth Ann. Rept., 1898.	
KANSAS.												
Allen County: Iola	Well	89.66	.....	.90	7.76	.45	CO 1.23	.....	.....	E. H. S. Bailey	U. S. Geol. Survey Mineral Resources, 1896.	

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Moran	do	92.00	.....	.30	6.35	.20	C_2H_4 .35 He .21 H .39 CO .20	.....	.....	Hamilton P. Cady and David F. McFarland.	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Collected July 13, 1906.
Iola	Main at office of Iola Gas Co.	94.50	.....	.....	5.08	.23	H trace. He .18 Other .01	.....	.....	do	Am. Chem. Soc. Jour., vol. 29, p. 1529.	Collected June 10, 1906.
Do	Several wells; main at Iola city gas office.	91.50	.....	.70	6.97	.40	CO .30 He .13	.....	.....	do	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Collected July 13, 1906.
Humbolt	City main	94.00	1.97	.....	2.98	.10	He .14 C_2H_4 .81	.....	.....	do	do	Do.
Allen and Neosho counties.	Several wells; mains of Kansas Natural Gas Co. at Lawrence.	94.30	.75	1.94	2.60	.24	He .17	.....	.....	do	do	Collected Dec. 12, 1906.
Anderson County:												
Garnett	City mains	94.30	.36	.20	4.61	.....	He .37 C_2H_4 .16	.....	.....	do	do	Depth 610 feet; pressure, 200 pounds; collected Aug. 1, 1906.
Butler County:												
Augusta	City supply	79.10	7.44	.....	12.44	.....	He .25 C_2H_4 .77	.....	.....	do	do	Depth, 1,440 feet; pressure, 650 pounds, collected Aug. 4, 1906.
Chase County:												
Elmdale	Wells	78.60	7.71	.15	12.13	.30	He .56 C_2H_4 .55	.....	.....	do	do	Depth, 152 feet; pressure, 45 pounds; collected Oct. 6, 1906.
Chautauqua County:												
Peru	Well	81.70	7.60	.51	9.39	.10	He .19 C_2H_4 .51	.....	.....	do	do	Collected July 20, 1906.
Coffey County:												
Burlington	City supply; high-pressure supply pipe wells south of Burlington.	85.50	3.20	.....	10.60	.....	He .50 C_2H_4 .20	.....	.....	do	do	Collected Aug. 4, 1906.
Cowley County:												
Dexter	Well	14.85	.41	.....	82.70	.20	H Tr. He 1.84	.....	.....	do	Am. Chem. Soc. Jour., vol. 29, p. 1529.	Depth, 310 feet; pressure, 110 pounds; collected 1905.
Do	Greenwell well	14.33	1.06	.....	82.87	.10	H Tr. He 1.64	.....	.....	do	do	Collected June 12, 1906.
Arkansas City	City supply	81.10	11.95	.10	6.39	.20	He .16 C_2H_4 .10	.....	.....	do	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Depth, 750 feet; pressure, 355 pounds.
Douglas County:												
Eudora	Town mains	88.60	.....	.62	10.20	.31	He .27	.....	.....	do	Am. Chem. Soc. Jour., vol. 29, p. 1529.	Depth, 350 feet; pressure, 200 pounds.
Lawrence	Old well	81.40	.....	.92	17.22	Tr.	He .46	.....	.....	do	do	Depth, 1,200 feet; collected July 4, 1906.

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Composition of natural gas in the principal producing regions—Continued.

State and district.	Collected from—	Constituents.						Specific gravity (air=1).	Heating value, calculated, per cubic foot.	Analyst.	Where published.	Remarks.
		Methane, marsh gas (CH_4).	Ethane (C_2H_6).	Carbon dioxide (CO_2).	Nitrogen (N).	Oxygen (O).	Other constituents.					
KANSAS—continued.												
Elk County:		*Per cent.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Per cent.*		*B. t. u.*			
Moline	Wells west and south of town.	74.10	.....	0.54	24.85	.....	H Tr. He 0.51	.....	.....	Hamilton P. Cady and David F. McFarland.	Am. Chem. Soc. Jour., vol. 29, p. 1529.	Depth, 1,150 feet; pressure, 380 pounds; collected June 24, 1906.
Greenwood County:												
Eureka	Town supply	51.40	.....	.20	46.40	0.50	He 1.50	.....	.....	do	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Collected Oct. 5, 1906.
Do	New field	51.80	.....	.20	46.40	.10	He 1.50	.....	.....	do	do	Do.
Johnson County:												
Spring Hill	City supply of Olathe	84.40	.....	.....	15.10	Tr.	He .40 C_2H_4 .10	.....	.....	do	do	Depth, 530 feet; pressure, 184 pounds; collected Aug. 2, 1906.
Miami County:												
Paola	Well	95.20	.11	.33	2.34	.45	CO 1.57	.....	.....	E. H. S. Bailey	Kansas Univ. Quart., vol. 4, no. 1, p. 10, 1895.	
Osawatomie	do	97.63	.22	.22	.60	.....	CO 1.33	.....	.....	do	do	
Do	City supply	98.00	.....	.70	.88	.40	He .01 Other .01	.....	.....	Hamilton P. Cady and David F. McFarland.	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Collected Aug. 3, 1906.
Montgomery County:												
Coffeyville	Well	96.41	.35	.....	2.21	.12	CO .91	.....	.....	E. H. S. Bailey	Kansas Univ. Quart., vol. 4, no. 1, p. 10, 1895.	
Cherryvale	.....	92.46	.....	.22	5.94	.22	CO 1.16	.....	.....	do	do	
Independence	.....	95.28	.67	.44	3.28	Tr.	CO .33	.....	.....	do	do	
Caney	Well east of Caney; Caney Gas & Mining Co.	92.40	.....	.81	6.46	.15	He .08 C_2H_4 .10	.....	.....	Hamilton P. Cady and David F. McFarland.	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Depth, 1,550 feet; pressure, 620 pounds; collected July 14, 1906.
Liberty and Coffeyville	Supply of Joplin district; Kansas Natural Gas Co.	95.70	.....	.92	2.69	.....	He .08 C_2H_4 .61	.....	.....	do	do	Depth, 950 feet; pressure, 450 pounds.

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Havana	Whistler well; Kansas Natural Gas Co.	72.13	13.80	.....	13.46	.18	Olefines	.43	.....	957.0	H. C. Allen	Unpublished	Analysis made by University of Kansas.
Liberty	Rossell well; Kansas Natural Gas Co.	83.04	8.54	.24	7.93	.25	.....		.....	970.0	.....do.....	.....do.....	Do.
Neosho County:													
Chanute	City supply; wells east of city.	94.70	.....	.....	4.96	.10	He	.24	.....	.....	Hamilton P. Cady and David F. McFarland.	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Depth, 850 feet; pressure, 200 pounds; collected July 24, 1906.
Do	Pipe line of Kansas Natural Gas Co. at Lawrence: Sample 1	98.00	.....	.....	1.88	.12	.....		.....	.....	.....do.....	Am. Chem. Soc. Jour., vol. 29, p. 1529.	Collected Oct. 23, 1905.
	Sample 2	98.06	.....	.20	1.57	Tr.	He	.17	.....	.....	.....do.....	.....do.....	Collected May 16, 1906.
Erie	City supply; wells east of town.	90.30	4.26	.33	4.45	.22	He C_2H_4 Other	.13 .30 .01	.....	.....	.....do.....	.....do.....	Depth, 510 feet; pressure, 150 pounds; collected July 3, 1906.
Wilson County:													
Eson district	Pipe line supplying Parsons; Prairie Oil & Gas Co.	91.90	3.37	.72	3.74	Tr.	He	.27	.....	.....	.....do.....	.....do.....	
Neodesha	Well	90.56	.22	1.00	7.07	.65	CO	.50	.....	.....	E. H. S. Bailey	Kansas Univ. Quart., vol. 4, no. 1, p. 10, 1895.	
Fredonia	Town supply	82.25	.....	.61	16.40	.....	He C_2H_4	.62 .12	.....	.....	Hamilton P. Cady and David F. McFarland.	Am. Chem. Soc. Jour., vol. 29, p. 1529.	Depth, 1,080 feet; pressure, 300–480 pounds.
New Albany	Well	89.10	.....	.20	9.84	.....	H He C_2H_4	.12 .49 .25	.....	.....	.....do.....	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Collected July 25, 1906.
Buffalo	Well inside town	96.20	.78	.....	2.46	.....	H CO He	.18 .11 .27	.....	.....	.....do.....	.....do.....	Collected July 8, 1906.
Altoona	.....	92.00	2.85	.92	3.97	.....	He	.26	.....	.....	.....do.....	.....do.....	Collected July 25, 1906.
Wyandotte County:													
Bonner Springs	Well of Bonner Portland Cement Co.	97.18	.....	.....	2.36	.10	H He	.25 .11	.....	.....	.....do.....	Am. Chem. Soc. Jour., vol. 29, p. 1529.	Depth, 600 feet; pressure, 190 pounds; collected July 8, 1906.
	Pipe line of Kansas Natural Gas Co. at Topeka.	94.56	.....	1.53	3.71	.20	.....		.....	.....	.....do.....	Kansas Univ. Geol. Survey, vol. 9, 1908.	Collected from stove tap in room of Glenwood Hotel, Dec. 22, 1907.
	Pipe line of Kansas Natural Gas Co. supplying Lawrence.	94.47	.....	1.85	3.68	Tr.	.....		.....	.....	.....do.....	.....do.....	Collected Dec. 23, 1907.

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Composition of natural gas in the principal producing regions—Continued.

State and district.	Collected from—	Constituents.						Specific gravity (air=1).	Heating value, calculated, per cubic foot.	Analyst.	Where published.	Remarks.
		Methane, marsh gas (CH_4).	Ethane (C_2H_6).	Carbon dioxide (CO_2).	Nitrogen (N).	Oxygen (O).	Other constituents.					
KENTUCKY.		*Per cent.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Per cent.*		*B. t. u.*			
Martin County, Ky., and Mingo County, W. Va.	Wells of United Fuel Gas Co.; gas taken from measuring station at Inez, Ky.	75.14	23.16	Tr.	1.59	0.11	.....	0.677	1,231.2	H. H. Craver, chemist.	Unpublished.....	Analyzed Jan. 8, 1914, Pittsburgh Testing Laboratory.
LOUISIANA.												
Caddo Parish:												
Caddo field.....	Well.....	95.00	.....	2.43	2.56	.....	Sulphide(?). 01	.....	980.0	F. C. Phillips.....	U. S. Geol. Survey Bull. 429, p. 138, 1910.	Collected by G. W. Barnes.
Calcasieu Parish:												
Jennings.....	Gas-producing oil well.	88.40	1.03	1.80	5.76	1.81	CO .40; He Tr.; C_2H_4 .80	.....	.....	Hamilton P. Cady and David F. McFarland.	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Small amount of air in sample; collected by A. Reineke, July, 1907.
Iberville Parish:												
Grosse Tete.....	S. R. Ely well.....	58.80	.....	1.40	39.80	.....	.....	.....	.....	G. A. Burrell.....	Unpublished.....	35.4 per cent of air extracted before analyzing; depth, 120 feet; collected July 17, 1910, by D. T. Day.
Whitecastle.....	.....	90.70	.....	4.20	5.10	.....	.....	.....	.....	.....do.....	.....do.....	Collected July, 1910, by D. T. Day.
Ouachita Parish:												
Monroe.....	.....	94.20	.....	1.40	4.40	.....	.....	.....	.....	.....do.....	.....do.....	16.8 per cent of air extracted before analyzing; collected July, 1910, by D. T. Day.
Terrebonne Parish:												
Montegut.....	Phyllis well, Lower Terrebonne Refining Co.	89.10	4.45	1.00	3.50	.10	H 1.75; H_2S Tr.; CO .10	.....	.....	Prof. Thile.....	U. S. Geol. Survey Bull. 429, 1910.	

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Washington Parish: Bogalusa		62.20		3.00	34.80	Tr.				G. A. Burrell	Unpublished	Collected 1910 by D. T. Day.
MISSOURI.												
Jackson County:												
Kansas City	Well at 2416 Tracy Avenue.	87.20	7.03	.60	3.65	.10	CO .20; He .01; C_2H_4 1.20; Other .01			Hamilton P. Cady and David F. McFarland.	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Depth, 300 feet; pressure very low.
Sheffield	Wells at Sheffield Nut & Bolt Works.	92.90		.83	5.43	.20	CO .10; He .04; C_2H_4 .50			do	do	Shallow wells; pressure 40 pounds.
NEVADA.												
Churchill County: Stillwater	Artesian well	72.36		4.22	22.86	.56				G. A. Burrell	Unpublished	Burns blue and white flame; depth, 345 feet; collected March, 1911, by C. V. Lindner.
Do	An old slough 15 inches in diameter.	95.60		1.26	3.14					do	do	Burns blue and white flame; collected March, 1911, by C. V. Lindner.
Do	Artesian well	70.91		5.01	23.66	.42				do	do	Burns blue and white flame; depth, 345 feet; collected March, 1911, by C. V. Lindner.
NEW YORK.												
Cattaraugus County: Olean		96.50	1.00			2.00	CO .50	.692		Robert Young	U. S. Geol. Survey Mineral Resources 1885, p. 235.	
Chautauqua County: Fredonia	Mains of Fredonia Natural Gas Light Co.	90.05		.41	9.54					F. C. Phillips	Pennsylvania Second Geol. Survey Ann. Rept., 1886, pt. 2, p. 800.	Collected, May 12, 1887.
Onondaga County: Baldwinsville	Well	98.40	.25		.40	Tr.	H Tr.; CO .95	.558	1,013.5	Dr. Durand Woodman.	New York Mus. Bull. 30, p. 468.	
Ontario County: West Bloomfield	do	82.41	2.94	10.11	4.31	.23		.693		Prof. Wurts	Am. Inst. Min. Eng., vol. 13, p. 542.	Analyzed 1870.

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Composition of natural gas in the principal producing regions—Continued.

State and district.	Collected from—	Constituents.						Specific gravity (air=1).	Heating value, calculated, per cubic foot.	Analyst.	Where published.	Remarks.
		Methane, marsh gas (CH_4).	Ethane (C_2H_6).	Carbon dioxide (CO_2).	Nitrogen (N).	Oxygen (O).	Other constituents.					
NORTH DAKOTA.												
Bottineau County:		*Per cent.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Per cent.*		*B. t. u.*			
Westhope	Wells of North Dakota Gas Co.	82.70	0.20	.....	12.40	3.00	H 0.50 CO 1.20	.....	.....	E. J. Babcock	U. S. Geol. Survey Bull. 431, p. 7, 1911.	Pressure, 55 to 60 pounds.
Lansford	.....	71.15	.10	.....	16.61	7.10	H 4.74 CO .30	.....	.....	do	do	Pressure, 18 to 20 pounds.
OHIO.												
Auglaize County:												
St. Marys	Wilkens well	93.85	.20	0.23	2.98	.35	H 1.74 H_2S .21 CO .44	.....	.....	Prof. C. C. Howard	U. S. Geol. Survey Mineral Resources, 1890, p. 491.	Trenton limestone.
Cuyahoga County:												
Cleveland	Well	93.50	.....	.20	6.30	.....	.....	.....	.....	F. C. Phillips	Am. Chem. Jour., vol. 16, p. 416, 1894.	Test made at well.
Fairfield County:												
Thurston field	do	90.48	.30	.25	8.12	.15	H .55 CO .15	.....	.....	Prof. C. C. Howard	Ohio Geol. Survey Bull. 4, p. 125.	
Hancock County:												
Findlay	Wells of Findlay Gas Light Co.	93.35	.35	.25	3.41	.39	H 1.64 H_2S .20 CO .41	.....	.....	do	U. S. Geol. Survey Mineral Resources 1890, p. 491.	
Do	.....	92.61	.30	.26	3.61	.34	H 2.18 H_2S .20 CO .50	0.570	.....	do	U. S. Geol. Survey Eighth Ann. Rept., p. 590 1889.	
Jefferson County:												
Near Toronto	High-pressure line of Manufacturers' Light & Heat Co.	34.08	62.08	.20	2.94	.70	.....	.912	1,515.0	W. P. Thompson, H. H. Craver.	Unpublished	
Near Horner		68.80	26.48	.10	4.22	.40	.....	.767	1,225.5	do	do	

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Knox County:												
Gambier	Neff well	81.40	12.20	.30	4.80	.80	CO	.50	640	Profs. Newberry and Morley.	Pennsylvania Second Geol. Survey, Rept. L, p. 147, 1875.	
Noble County:												
Dexter City	Well No. 1, Mitchell farm, Bull Run, near city.	97.00	.70	.11	1.00	.30	CO	.80		Chas. F. Mabery and Orton C. Dunn.	Am. Chem. Jour., vol. 18, p. 224.	
Do	Well No. 8, Dunn farm, near city.	91.20	2.60	.30	1.20	4.00	CO	.40		do	Am. Chem. Jour., vol. 18, p. 223.	
Richland County:												
Butler	Well of F. O. Levering.	70.00	16.75		12.38	.05	H	.27		Hamilton P. Cady and David F. McFarland	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Collected July 19, 1906.
							He	.15				
							C_2H_4	.40				
Seneca County:												
Fostoria	Water-tank wells	92.84	.20	.20	3.82	.35	H_2S	.15		C. C. Howard	U. S. Geol. Survey Mineral Resources, 1890, p. 491.	
							H	1.89				
							CO	.55				
OKLAHOMA.												
Kay County:												
Blackwell	Well No. 2, Union Oil & Gas Co.	83.40	10.31		5.19		H	.33		Hamilton P. Cady and David F. McFarland.	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Pressure 185 pounds.
							He	.16				
							C_2H_4	.61				
Glennpool	Gas from oil wells	49.1	44.1	6.1	.7				.768	1,271	G. A. Burrell	Bur. Mines Bull. 42, 1913.	
Stevens County:												
Duncan	Wells of Western Oklahoma Gas & Fuel Co.	96.20		.20	2.40	.60	CO	.40		1,025	Gulick Henderson.	Unpublished	Analysis made Oct. 27, 1913.
							Ethylene	.20				
OREGON.												
Northwestern	Slough on Brown's dairy farm.	95.50		3.50	1.00						G. A. Burrell	do	Collected by G. N. Macready and R. F. Rogers, September, 1910.
Do	do	95.70		3.30	1.00						do	do	Collected by C. W. Washburne.
Do	Bed of Whalen River at Luhkarela ranch.	86.20		.70	13.10						do	do	Collected by G. A. Macready, September, 1910.
Do	Herrick Mineral Spring, Grand Rapids, Whalen River.	87.00		.50	12.50						do	do	Do.
Do	Slough on Brown's dairy farm.	96.10		3.00	.90						do	do	Collected by G. A. Macready and R. F. Rogers, September, 1910.
Tillamook	Well 5½ miles southwest of town.	2.00		.15	97.85						do	do	Collected by G. A. Macready, September, 1910.

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Composition of natural gas in the principal producing regions—Continued.

State and district.	Collected from—	Constituents.						Specific gravity (air=1).	Heating value, calculated, per cubic foot.	Analyst.	Where published.	Remarks.
		Methane, marsh gas (CH_4).	Ethane (C_2H_6).	Carbon dioxide (CO_2).	Nitrogen (N).	Oxygen (O).	Other constituents.					
PENNSYLVANIA.												
Allegheny County: Creighton	Well	*Per cent.* 96.36	*P. ct.* Tr.	*P. ct.* 3.64	*P. ct.*	*P. ct.*	*Per cent.*	0.592	*B. t. u.*	F. C. Phillips	U. S. Geol. Survey Mineral Resources, 1885, p. 235.	Test made at well.
Allegheny and Washington counties.	Walker's Mills line of People's Natural Gas Co.	74.06	24.30	.....	1.64	Tr.	.....	.664	1,240.9	H. H. Craver	Unpublished	Gas taken at pump station.
Do	Candor line of People's Natural Gas Co.	80.67	17.46	.....	1.41	0.46	.....	.642	1,184.0	.....do.....	.....do.....	Do.
Do	Imperial 10-inch line People's Natural Gas Co.	75.09	23.62	.....	1.07	.22	.....	.662	1,239.2	.....do.....	.....do.....	Do.
Allegheny County: Pittsburgh	Painter & Co.'s well.	98.90	.....	.40	.70	.....	.....	.....	.....	F. C. Phillips	Am. Chem. Jour., vol. 16, p. 416, 1894.	Test made at wells.
Do	Exhibition grounds.	92.18	.....	.52	7.30	Tr.	.....	.....	.....	.....do.....	.....do.....	Do.
Do	Salt well in Allegheny.	92.60	.....	.30	7.10	.....	.....	.....	.....	.....do.....	.....do.....	Do.
Beaver County: Baden	Bryan No. 1 well, Baden Gas Co.	87.27	.....	.41	12.32	Tr.	.....	.....	.....	.....do.....	Pennsylvania Geol. Survey Ann. Rept., 1886, pt. 2, p. 811.	Collected May 18, 1887.
Racoon Creek	Main Bridgewater Natural Gas Co.	90.09	.....	Tr.	9.91	Tr.	Tr.	.....	.....	.....do.....	Pennsylvania Geol. Survey Ann. Rept., 1886, pt. 2, p. 810.	Collected May 2, 1887.

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Butler County:													
Burns	Well No. 1	75.75	17.84	.34	.....	.....	CO, &c. .01; H 6.06	.615	.....	S. P. Sadtler	Pennsylvania Second Geol. Survey, Rept. L, p. 149, 1875.	
	Well No. 2	75.12	18.39	.35	.....	.....	CO, &c. .01; H 6.13					
Harvey	Well	80.11	5.72	.66	.....	.....	CO, &c. .01; H 13.50	.512	.....	do	Pennsylvania Second Geol. Survey, Rept. L, pp. 152-160, 1875.	
Greene County	Wells People's Natural Gas Co.	73.14	23.81	.....	2.85	.20	.....	.736	1,222	H. H. Craver and W. P. Thompson.	Unpublished	
Indiana County:												
Cherrytree	A spring	60.27	6.80	2.28	7.32	.83.	H 22.50	.....	.....	S. P. Sadtler	Pennsylvania Second Geol. Survey, Rept. L, pp. 152-160, 1875.	
McKean County:												
Kane	Wilcox well No. 7, United Natural Gas Co.	90.38	.....	.21	9.41	Tr.	.....	.....	.....	F. C. Phillips	Pennsylvania Geol. Survey Ann. Rept., 1886, pt. 2, p. 803.	Collected Jan. 29, 1887.
Do	Well No. 1, Kane Natural Gas Co.	90.01	.....	.20	9.79	Tr.	.....	.....	.....	do	do	Collected Jan. 30, 1887.
Venango County:												
Oil City	Main of Northwestern Natural Gas Co.	95.42	.....	.05	4.51	Tr.	H .02	.....	.....	do	Pennsylvania Geol. Survey Ann. Rept., 1886, pt. 2, p. 805.	Speechley gas. Collected Apr. 12, 1887.
Warren County:												
Sheffield	Wells 1, 2, and 3 of Sheffield Gas Co.	90.64	.....	.30	9.06	Tr.	.....	.....	.....	F. C. Phillips	Pennsylvania Geol. Survey Ann. Rept., 1886, pt. 2, p. 802.	
Washington County:												
Houston	Well	84.26	.....	.44	15.30	Tr.	.....	.....	.....	do	Pennsylvania Geol. Survey Ann. Rept., 1886, pt. 2, p. 811.	Collected Mar. 18, 1887. Contains also trace of ammonia.
	Line of Peoples Natural Gas Co.	81.59	17.76	.....	.65	Tr.	.....	.665	1,199.0	H. H. Craver	Unpublished	
McDonald	Gas from oil wells	1.90	67.30	.10	.60	.....	Air 30.10	.....	1,204.0	G. A. Burrell	Bur. Mines Bull. 42, 1913.	
Do	do	2.70	96.10	.20	1.00	.....	.....	1.011	1,719.0	do	do	
Do	do	.....	.....	2.10	23.00	.....	C_6H_{12} 40.6; C_3H_8 34.3	1.590	2,185.0	do	do	

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Composition of natural gas in the principal producing regions—Continued.

State and district.	Collected from—	Constituents. Methane, marsh gas (CH_4).	Ethane (C_2H_6).	Carbon dioxide (CO_2).	Nitrogen (N).	Oxygen (O).	Other constituents.	Specific gravity (air=1).	Heating value, calculated, per cubic foot.	Analyst.	Where published.	Remarks.
PENNSYLVANIA—contd.												
Washington County—Continued.		*Per cent.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Per cent.*		*B. t. u.*			
McDonald	Gas from oil wells			1.50	16.50		C_4H_{10} 29.0; C^2H_6 24.5; Air 28.5		1,561.0	G. A. Burwell	Bur. Mines Bull. 42, 1913.	
	R. A. Geary deep well No. 770 of Peoples Natural Gas Co.	88.83		3.6	6.77	0.8			946.0	James O. Handy	Unpublished	Collected June 25, 1912. Sample shows indications of being contaminated with ammonia.
		65.07	24.80	.10	9.13	.9			1,154.5	do	do	Collected Aug. 10, 1912.
		[a]81.88	14.75	Tr.	3.37				1,146.8	H. H. Craver	do	Collected Apr. 1, 1914.
		[b]29.97	5.40	Tr.	51.77	12.86						Sample contained air.
Westmoreland County:												
Leechburg	Well	89.65	4.95	.35			CO .26; H 4.79	0.558		S. P. Sadtler	Pennsylvania Second Geol. Survey, Rept. L, p. 152, 1875.	
Murrysville	do	95.40		.20	4.40	Tr.				F. C. Phillips	Am. Chem. Jour., vol. 16, p. 416, 1894.	Test made at well.
Murrysville, Lyons Run district.	Hukill well, Philadelphia Co.	97.70		.28	2.02	Tr.				do	Pennsylvania Second Geol. Survey, pt. 2, p. 800, 1886.	Collected Apr. 8, 1867.
Grapeville		35.08	28.87	.58	27.87	.16	H 7.05; CO .22; Olefiant gas .17			Mr. Morrell	Am. Inst. Min. Eng., vol. 15, p. 531.	Analyses made February, 1886.
		14.93	39.64	Tr.	18.69	1.22	H 24.56; CO Tr.; Olefiant gas .96					
PENNSYLVANIA AND WEST VIRGINIA.	City of Pittsburgh supply.	83.00	16.40		.60			.640	1,189.0	G. A. Burrell	Bur. Mines Tech. Paper 10, 1912.	

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SOUTH DAKOTA.												
Hughes County:												
Pierre	Gas from artesian well.	73.2	.....	1.14	21.7	3.19	He Trace. Olefins .25 Other .52	.....	.....	Cady and McFarland.	Kansas Univ. Geol. Survey, vol. 9, 1908.	Collected by Doane Robinson. Sample contained some air.
TENNESSEE.												
Shelby County:												
Memphis	Seepage	90.36	.....	3.13	3.83	.83	H	1.85	.....	G. A. Burrell	Unpublished	Collected December, 1911, by Dutro, Trimble & Munn.
TEXAS.												
Clay County:												
Petrolia	Dallas Gas Co.	47.20	12.50	.20	38.60	.40	H .80 Illum. .30	.720	474.0	C. C. Tutwiler	U. S. Geol. Survey Mineral Resources, 1911.	Sample received by United Gas Improvement Co., Philadelphia, Pa., Sept. 9, 1909.
Do	do	55.90	5.50	.....	36.80	.20	H 1.00 CO .30 Illum. .30		561.0	do	Texas Univ. Bull. 246, 1912.	Sample received by United Gas Improvement Co., Philadelphia, Pa., November, 1910.
Do	.....	67.93	.....	.....	30.57	.70	CO Tr. Illum. .80	.....	715.0	W. M. Russell	do	Analysis made in 1909.
Do	Supply city of Dallas	56.80	.....	.....	43.20	.....	.....	.....	649.0	S. H. Worrell	do	Analysis made June 4, 1912.
Gonzales County	Well 9 miles west of Gonzales.	85.40	.....	.....	14.60	.....	.....	.....	862.5	do	Texas Univ. Bull. 307, 1913.	
Houston County	Locality 14 miles west of Crockett.	90.40	.....	.....	9.40	.20	.....	.....	913.0	do	do	
McMullen County:												
Crowther	Wells of Boston & Texas Corporation.	74.00	.....	.40	2.60	.20	H 22.80	.458	947.0	do	do	
Maverick County	Fleming & Davidson well (712 feet).	34.80	.....	.....	62.60	1.40	CO 1.2	.826	300.5	do	do	
Red River County	Gas bubbling up through Red River at mouth of Cash Creek.	48.30	.....	5.2	18.10	2.60	H 25.8	.....	463.0	do	do	
Shackelford County:												
Moran	Main line, 16 miles from wells at Moran.	80.80	.....	.....	19.2	.....	.....	.....	835.5	do	do	
Trinity County	Spring 1 mile east of Trinity.	92.0	.....	.....	8.0	.....	.....	.588	929.0	do	do	
Webb County	Gas supply of Laredo from wells of Border Gas Co.	85.2	.....	.....	14.8	.....	.....	.614	726.0	do	do	
		66.3	.....	.....	32.7	.60	CO 4.	.....	564.0	do	do	

[a] Calculated to free-air basis.

[b] Sample as received.

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Composition of natural gas in the principal producing regions—Continued.

State and district.	Collected from—	Constituents.						Specific gravity (air=1).	Heating value, calculated, per cubic foot.	Analyst.	Where published.	Remarks.
		Methane, marsh gas (CH_4).	Ethane (C_2H_6).	Carbon dioxide (CO_2).	Nitrogen (N).	Oxygen (O).	Other constituents.					
UTAH.												
Grand County:		*Per cent.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Per cent.*		*B. t. u.*			
Moab		90.80	.....	3.60	5.60	.....	.....	.....	.....	G. A. Burrell	Unpublished	Collected by A. H. Rogers, September, 1911.
Do		90.00	.....	3.50	6.50	.....	.....	.....	.....	U. S. Geol. Survey Laboratory.	U. S. Geol. Survey Bull. 471, 1910.	Collected by A. H. Rogers.
Salt Lake County:												
Salt Lake City	12 miles north of city.	22.30	37.8	.80	19.70	0.90	H 16.6 CO 1.2 Ethylene .7	.....	.....	J. T. Kingsbury	U. S. Geol. Survey Bull. 260, p. 481, 1905.	
WASHINGTON.												
Wahkiakum County:												
Oneida	John Nelson's ranch (1).	91.20	.....	1.20	7.60	.....	.....	.....	.....	G. A. Burrell	Unpublished	Collected September, 1910, by G. A. Macready.
	John Nelson's ranch (2).	91.00	.....	1.00	8.00	.....	.....	.....	.....			
WEST VIRGINIA.												
Brooke County:												
Follansbee	Gas from oil wells	.....	21.8	.....	.50	.....	C_2H_6 77.7	1.390	2,468	.....do.....	Bur. Mines Tech. Paper 10, 1912.	
		.....	10.8	.....	.90	.....	C_2H_6 88.3	1.462	2,407	.....do.....	Bur. Mines Bull. 42, 1913.	
		.....	21.4	.....	.40	.....	C_2H_6 78.2	1.410	2,339	.....do.....	.....do.....	
		.....	28.5	.....	.40	.....	C_2H_6 71.1	1.380	2,286	.....do.....	.....do.....	
		.....	24.8	.....	.30	.....	C_2H_6 61.9 Air 13.0	.....	1,990	.....do.....	.....do.....	
Do	Wells of Hope Natural Gas Co.	72.38	26.55	Tr.	1.07	Tr.	.....	.703	1,261.1	H. H. Craver	Unpublished	Gas from an old field.
Doddridge, Harrison, and Lewis counties.	.....do.....	80.50	18.00	.....	1.50	Tr.	.....	.653	1,192.2	.....do.....	.....do.....	Gas from Bates measuring station.
Doddridge and Tyler counties.	.....do.....	75.80	23.54	Tr.	.66	Tr.	.....	.691	1,245.3	.....do.....	.....do.....	Gas from Smith measuring station.

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Doddridge and Wetzel counties.	.....do.....	75.27	24.20	.....	.53	Tr.	.....	.727	1,252	.....do.....	.....do.....	
Harrison County.....	City supply, Shinnston; J. B. Cunningham well No. 1, Gordon sand.[a]	80.85	15.08	.....	3.47	.10	H .10 CO .40	.....	1,143.6	C. D. Howard, June, 1904.	West Virginia Geol. Survey, vol. 1a, p. 556, 1904.	Well 3¼ miles northwest of Shinnston. Top of sand 2,199 feet below Pittsburgh coal.
Do.....	Harbert well No. 1 (fifth sand gas), near West Fork River.[a]	80.70	14.45	.10	3.95	.30	H .10 CO .40	.....	1,131.4	.....do.....	.....do.....	Well ¾ mile east of Lumberport; 2,390 feet below Pittsburgh coal.
Do.....	Lucas Bros. well No. 4 (50-foot sand), near mouth Robinson Run.[a]	86.48	7.85	.....	4.87	.30	CO .50	.....	1,065.3	.....do.....	.....do.....	Well 1 mile west of Shinnston. Top of sand 1,855 feet below Pittsburgh coal.
Do.....	Lucas Bros. well No. 1 (Big Injun sand).[a]	79.95	15.09	.....	3.96	.20	CO .40 Heavy hydrocarbons .40	.....	1,140.9	.....do.....	.....do.....	Well 1¼ miles northwest of Shinnston. Top of sand 1,421 feet below Pittsburgh coal.
Lewis County.....	Wells of Hope Natural Gas Co.	82.58	16.65	.13	.38	.26	.....	.646	1,189.2	H. H. Craver and W. P. Thompson.	Unpublished.....	Analysis made at Pittsburgh Testing Laboratory.
Do.....	.....do.....	81.90	16.12	.12	1.26	.60	.....	.651	1,172	.....do.....	.....do.....	Do.
Lewis and Harrison counties.	.....do.....	87.90	7.30	.....	4.40	.40	.....	.....	1,071	.....do.....	.....do.....	Do.
Marion County:												
Fairmont.....	City supply, Bayard sand.	81.60	14.29	.10	3.21	.20	H .20 CO .40	.....	1,136.9	C. D. Howard.....	West Virginia Geol. Survey, vol. 1a, p. 556, 1904.	Tested June, 1904.
Do.....	Wells of Hope Natural Gas Co.	59.69	39.10	.....	1.21	Tr.	.....	.790	1,363	H. H. Craver.....	Unpublished.....	
Do.....	.....do.....	73.50	23.90	.....	2.10	.50	.....	.723	1,228	.....do.....	.....do.....	
Do.....	.....do.....	43.20	54.72	.....	1.78	.30	.....	.843	1,478	.....do.....	.....do.....	
Marion, Harrison, and Monongalia counties.	.....do.....	82.13	16.84	Tr.	.83	.20	.....	.651	1,186.4	.....do.....	.....do.....	Gas taken from Morgan measuring station.
Marshall County.....	George Hicks well No. 987 of Manufacturers' Light & Heat Co.	76.44	21.32	.....	1.89	.35	.....	.658	1,210.7	H. H. Craver and W. P. Thompson.	.....do.....	
Do.....	J. W. Richey well No. 1663 of Manufacturers' Light & Heat Co.	77.92	20.74	.....	1.23	.11	.....	.....	1,215.7	.....do.....	.....do.....	
Monongalia County:												
Morgantown.....	Well No. 1, 10 miles west of town.	88.10	7.37	.....	3.60	.....	H .25 CO .24 He .09 C_2H_6, &c. .35	.....	.....	Hamilton P. Cady and David F. McFarland.	Am. Chem. Soc. Jour., vol. 29, p. 1530.	Depth, 1,800 feet; pressure, 160 pounds; collected by B. H. Hite,. Aug 18, 1906.

[a] Fairmont & Grafton Gas Co.

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Composition of natural gas in the principal producing regions—Continued.

State and district.	Collected from—	Constituents.						Specific gravity (air = 1).	Heating value, calculated, per cubic foot.	Analyst.	Where published.	Remarks.
		Methane, marsh gas (CH_4).	Ethane (C_2H_6).	Carbon dioxide (CO_2).	Nitrogen (N).	Oxygen (O).	Other constituents.					
WEST VIRGINIA—con.		*Per cent.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Per cent.*		*B. t. u.*			
Monongalia (W. Va.) and Greene (Pa.) counties.	Morgantown supply (Big Injun sand).	80.94	14.60	a0.006	3.46	0.20	H Tr. CO 0.40 Heavy hydrocarbons .40	.....	1,142.6	C. D. Howard.....	West Virginia Geol. Survey, vol. 1a, p. 556, 1904.	Tested June, 1904.
New Martinsville.....	High-pressure line of Manufacturers' Light & Heat Co.	72.11	26.65	.....	1.24	Tr.	.....	0.676	1,263.8	H. H. Craver and W. P. Thompson.	Unpublished.....	Tested at Pittsburgh Testing Laboratory.
Roane County: Spencer and Curtis districts.	Gas taken at Ravenswood; United Fuel Gas Co.	81.81	17.41	.....	.78	Tr.	.....	.674	1,195.2	.....do.....	.....do.....	Tested at Pittsburgh Testing Laboratory, Feb. 13, 1914.
Wellsburg.....	Wellsburg shop high-pressure line of Manufacturers' Light & Heat Co.	78.20	19.60	.....	2.20	.....	.....	.806	1,197.5	.....do.....	.....do.....	Tested at Pittsburgh Testing Laboratory.
Wheeling.....	High-pressure line of Manufacturers' Light & Heat Co.	74.95	24.51	Tr.	.39	.15	.....	.668	1,254	.....do.....	.....do.....	Do.
General.....	Wells of Hope Natural Gas Co.	81.20	17.11	.....	1.47	.22	.....	.649	1,183.0	H. H. Craver and W. P. Thompson.	Unpublished.....	Tested at Pittsburgh Testing Laboratory.
General northern...	.....do.....	82.35	16.00	.....	1.40	.25	.....	.645	1,174.0	.....do.....	.....do.....	Do.
Do.....	.....do.....	79.72	16.19	Tr.	3.64	.45	.....	.656	1,150.0	.....do.....	.....do.....	Do.
General, Hastings Station.	.....do.....	85.37	14.08	.....	.55	Tr.	.....	.649	1,171.0	.....do.....	.....do.....	Do.
Unknown.....	.....do.....	75.14	23.16	Tr.	1.59	.11	.....	.677	1,231.0	.....do.....	.....do.....	Do.
WYOMING.												
Bighorn County: Byron.....	Gas from oil well...	64.05	32.28	.47	3.20	.....	.....	.680	1,282.0	G. A. Burrell.....	Bur. Mines Tech. Paper 57, 1913.	Collected by W. R. Calvert, December, 1912.

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Greybull	do	51.55	47.20	.....	1.25	.....	.....	.770	1,427.0	do	do	Do.
Do	Island No. 1 gas well.	81.70	17.35	.20	.75	.....	.....	.640	1,192.0	do	do	Do.
Converse County:													
Douglas	Well	87.75	7.23	.21	Tr.	Tr.	H 3.89 CO Tr. Illum., etc. .92	.589	.....	Frederick Salathe.	U. S. Geol. Survey Bull. 541C, 1914.	Analysis made in 1904.
Natrona County:													
Salt Creek	Gas from oil wells of Mid-West Oil Co.	.....	60.40	.....	28.97	.....	C_2H_2 10.63	.960	1,437.0	G. A. Burrell	Bur. Mines Tech. Paper 57, 1913.	Collected by W. R. Calvert.
FOREIGN.													
Austria:													
Wels		97.10	.....	1.30	1.00	.60	.....	.567	.....	J. Frank	Jour. Gasbel., vol. 55, pp. 154–155.	
Canada:													
Calgary, Alberta		90.00	.....	.....	8.50	.10	H 1.4 H 4.70 Heavy hydrocarbon vapors 1.80	.....	.....	E. Stansfield	Unpublished	Tested, July, 1913.
Do		92.06	.....	.....	1.44	Tr.		.....	.....	M. F. Connor	do	Tested, May, 1910.
Vancouver, British Columbia.		93.56	.....	.14	6.30	.....	.....	.....	.....	F. C. Phillips	Am. Chem. Jour., vol. 16, p. 416, 1894.	Collected by C. F. Hutchings.
Welland, Ontario	Point Albino well	96.57	.....	Tr.	2.69	.....	H_2S .74	.....	.....	do	Am. Chem. Soc. Jour., vol. 20, p. 700, 1898.	
Moosomin, Saskatchewan.		83.40	.....	.....	14.4	.3	H 1.8 Ethylene .1	.....	.....	E. Stansfield	Unpublished	Tested, June, 1913.
Germany:													
Neuengamme, near Hamburg.		91.50	2.10	.30	4.60	1.50	.....	.....	.....	Dr. Schertel	Jour. Gasbel., vol. 54, pp. 193–198.	
Hungary	Unutilized wells	92.05	.....	.65	7.30	.....	.....	.....	.....	.....	Oesterr. Chem. Tech. Zeitung, vol. 28, p. 16.	
New Zealand:													
Gisborne field, Whatatutu district.	Oil spring at Waitangi Hill.	96.5	.....	3.5	.....	.....	.....	.....	.....	.....	Oil fields of New Zealand, J. D. Henry, 1911.	
Taranaki field, Taranaki district.	Oil well of Taranaki Petroleum Co.	24.4	16.3	49.2	8.8	1.3	.....	.....	.....	.....	do	
Do	do	22.7	25.8	43.7	6.5	1.3	.....	.....	.....	.....	do	
Wairarapa (eastern) field, Akitio district.	Gas spring at Spring Hill.	35.3	17.6	.....	35.1	12.0	.....	.....	.....	Dr. MacLaurin	do	Collected by D. Laing, July, 1910.
Russia:													
Samara	Well at Nov-Usensk.	53.35	.40	1.17	40.86	4.22	.....	.....	.....	.....	Jour. Petroleum, vol. 5, p. 517.	

[a] Determined by barium hydrate.

[b] Including butane and propane.

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In comparison with the composition shown in the foregoing tables for natural gas, the following table gives for comparison the general composition of coal gas, water gas, and producer gas from bituminous coals. The weights in pounds, the specific gravity, and the usual number of heat units per thousand cubic feet of the various gases are given according to the usually accepted values.

Analysis, weight, and heating quality, per 1,000 feet, and specific gravity, of natural and manufactured gases.

Constituent.	Average of coal gas.	Average of water gas.	Average of producer gas from bituminous coal.
	Per cent.	*Per cent.*	*Per cent.*
Marsh gas (CH_4)	40.00	2.00	2.05
Other hydrocarbons	4.00	.00	.04
Nitrogen	2.05	2.00	56.36
Carbonic acid (CO_2)	.45	4.00	2.60
Carbonic oxide (CO)	6.00	45.50	27.00
Hydrogen	46.00	45.00	12.00
Hydrogen sulphide	.00	.00	.00
Oxygen	1.50	1.50	.05
Total	100.00	100.00	100.00

Average gases.	Pounds in 1,000 cubic feet.[a]	Specific gravity, air being 1.	British thermal units per 1,000 cubic feet.[b]
Natural gas:			
Pennsylvania and West Virginia	47.50	0.624	1,145,000
Ohio and Indiana	48.50	.637	1,095,000
Kansas	49.00	.645	1,100,000
Coal gas	33.00	.435	755,000
Water gas	45.60	.600	350,000
Producer gas from bituminous coal	75.00	.985	155,000

[a] 1,000 cubic feet of air at an atmospheric pressure of 14.7 pounds and at a temperature of 62° F. weighs 76.1 pounds and is a mechanical mixture of 23 parts of oxygen and 77 parts of nitrogen by weight.
[b] A British thermal unit is the heat necessary to raise the temperature of 1 pound of pure water at 39° F. 1°.

GASOLINE FROM NATURAL GAS.

PRODUCTION.

The extraction of gasoline from casing-head gas (natural gas from oil wells) has become one of the important adjuncts of the natural-gas industry in the United States. Statistics of the production of this kind of gasoline have been collected for the last three years, the results of which will be found in the tables which follow. It will be seen that the production is increasing rapidly, the quantity produced in 1913 being almost double that of 1912. This increased production was due to the installation of a greater number of plants and to the advance in the price of gasoline.

A description of the processes employed in the extraction of gasoline from natural gas was given in this report for the year 1911 and need not be repeated further than to say there are two methods in use—one the regular compressor plant, the other the "gas-pump" or vacuum process.

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The natural-gas gasoline industry was strictly confined to nine States in 1913 named as follows, according to the quantity of gasoline produced: West Virginia, Oklahoma, Pennsylvania, California, Ohio, Illinois, Colorado, New York, and Kansas, the only production in Kentucky coming from natural condensation in the pipes. The total quantity of gasoline produced in 1913 amounted to 24,060,817 gallons, valued at $2,458,443, an average price of 10.22 cents per gallon, as compared with a production of 12,081,179 gallons, valued at $1,157,476, in 1912, and 7,425,839 gallons, valued at $531,704, in 1911. It is interesting to note the changes in the chief producing States, all of which show increase, greater or less, in both quantity and value of product, West Virginia taking the lead in all three years.

The majority of the compressor plants are erected near the oil wells by the owners or operators of the wells from which they are to receive their supply of gas, but in many cases these operators also buy gas from neighboring oil wells. Some gasoline producers purchase all the gas that they use. Gas is usually purchased on a royalty basis, that is, on a certain proportion of the gasoline produced or of the proceeds of the sales from the gasoline, royalties ranging from one-fourth to one-third, to three-eighths, and to one-half. Gas is also purchased at so much per well per month, or at so much per thousand cubic feet, the price ranging from 3 to 10 cents. The residue, or "exhaust" gas, is usually returned to the producer and is used on leased properties; it is also sold to the gas-distributing companies, or to consumers for industrial use, or is allowed to escape into the air and is wasted.

The uses of natural-gas gasoline are many and varied. It is principally used for raising the standard of naphthas or low-grade distillates consumed in motors; it is also used for lighting; and it can be used in all the arts like regular gasoline. There is an ever-increasing demand for it for automobiles.

In the following tables are given statistics of the production of gasoline from natural gas in the United States in the years 1911, 1912, and 1913, by States:

Production of gasoline from natural gas in the United States in 1911, 1912, and 1913, by States.

1911.

State.	Number of operators.	Plants.		Gasoline produced.			Gas used.		Average yield in gasoline.
		Number.	Daily capacity.	Quantity.	Value.	Price per gallon.	Estimated quantity.	Value.	
			Gallons.	*Gallons.*		*Cents.*	*Cubic feet.*		*Gallons.*
West Virginia	47	72	16,819	3,660,165	$262,661	7.18	1,252,900,600	$76,074	2.92
Ohio	26	39	6,454	1,678,985	118,161	7.04	469,672,000	37,574	3.57
Pennsylvania	43	50	5,669	1,467,043	109,649	7.47	526,152,663	52,618	2.79
Oklahoma	8	8	4,800	388,058	20,975	5.40	144,629,000	4,378	2.68
California, Colorado, Illinois, New York, Kentucky [a]	8	7	3,358	231,588	20,258	8.75	82,343,000	6,320	2.81
Total	132	176	37,100	7,425,839	531,704	7.16	2,475,697,263	176,961	3.00

[a] The only gasoline produced in Kentucky came from natural condensation in the pipes.

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Production of gasoline from natural gas in the United States in 1911, 1912, and 1913, by States—Continued.

1912.

State.	Number of operators.	Plants.		Gasoline produced.			Gas used.		Average yield in gasoline.
		Number in operation.	Daily capacity.	Quantity.	Value.	Price per gallon.	Estimated quantity.	Value.	
			Gallons.	*Gallons.*		*Cents.*	*Cubic feet.*		*Gallons.*
West Virginia	66	97	22,366	5,318,136	$513,116	9.6	1,972,882,212	$163,749	2.8
Pennsylvania	69	83	10,524	2,041,109	217,016	10.6	722,730,117	62,010	2.8
Ohio	25	43	7,791	1,718,719	173,421	10.1	576,123,700	46,090	2.98
Oklahoma	11	13	11,910	1,575,644	99,626	6.3	701,044,300	24,901	2.25
California	7	7	6,669	1,040,695	112,502	10.8	600,743,000	25,573	1.7
Illinois	4	4							
Colorado	2	2							
New York	1	1	2,008	386,876	41,795	10.8	114,273,000	9,662	3.4
Kentucky	1	(a)							
Total	186	250	61,268	12,081,179	1,157,476	9.6	4,687,796,329	331,985	2.6

1913.

West Virginia	63	115	31,930	7,662,493	$807,406	10.54	2,981,119,000	$181,337	2.57
Oklahoma	19	40	61,633	6,462,968	577,944	8.94	2,152,503,000	82,742	3.00
Pennsylvania	100	113	22,207	3,680,096	405,186	11.01	1,372,056,000	114,783	2.68
California	12	14	21,135	3,460,747	376,227	10.87	2,436,445,000	106,539	1.42
Ohio	25	41	8,142	2,072,687	212,404	10.25	744,226,000	63,233	2.79
Illinois	6	12							
Colorado	2	2							
New York	3	3	7,368	721,826	79,276	10.98	203,092,500	17,590	3.55
Kansas	1	1							
Kentucky	1	(a)							
Total	232	341	152,415	24,060,817	2,458,443	10.22	9,889,441,500	566,224	2.43

a Drips.

WEST VIRGINIA.

The production of natural-gas gasoline in West Virginia has exceeded that of any other State in the years 1911, 1912, and 1913. The production in 1913 amounted to 7,662,493 gallons, valued at $807,406, as compared with 5,318,136 gallons, valued at $513,116, in 1912, and with 3,660,165 gallons, valued at $262,661, in 1911. For the first time the statistics of production by counties are given. They are approximately correct. Many of the plants installed in 1913 were in operation only a portion of the year, and the indications are that the production in the future will be considerably increased.

It will be seen that the greater number of plants in operation in 1913 are located in Tyler County, which took the lead in quantity and value of gasoline produced, the production amounting to 3,228,641 gallons. Pleasants County takes second place in number of plants in operation, but not in capacity or production, Ritchie County taking second place in this respect, with a production of 1,440,531 gallons. Brooke County is third in production, followed by Wetzel, Pleasants, Hancock, Wood, and Kanawha.

In the table following is given the production of gasoline from natural gas in West Virginia in 1913, by counties.

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Production of gasoline from natural gas in West Virginia in 1913, by counties.

County.	Plants.		Gasoline produced.		Average yield in gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
	Number in operation.	Daily capacity.	Quantity.	Value.		
		Gallons.	*Gallons.*		*Gallons.*	° *Baumé.*
Tyler	47	13,011	3,228,641	$344,296	1.5–10	70 –97
Ritchie	15	6,710	1,440,531	146,804	1 – 4	82 –96
Brooke	6	1,960	711,867	74,242	2.5– 3	85 –96
Wetzel	4	840	[a] 683,437	74,412	1.5– 2	60 –86
Pleasants	17	2,070	459,285	41,275	1 – 4	80 –97
Hancock	5	1,825	301,125	37,471	2 – 4.6	86 –92
Wood	9	660	198,232	21,089	1.5– 5.5	80 –105
Kanawha	4	2,564	144,699	15,908	2 – 6	85.2–91.5
Calhoun	2	550				
Clay	1					
Wirt	1					
Marion	1	1,740	494,576	51,909	1 – 3	80 –91
Marshall	1					
Harrison	1					
Doddridge	1					
Total	115	31,930	7,662,493	807,406	2.57	.....

[a] Includes drips.

In the following table is given the yield of natural gas in gasoline in West Virginia in the years 1911 and 1912, by counties:

Yield of natural gas in gasoline in West Virginia in 1911 and 1912.

Location of plant.	County.				Yield in gasoline per thousand cubic feet of gas.		Average gravity of gasoline as produced and before blending.	
	Number of operators.		Number of plants in operation.					
	1911	1912	1911	1912	1911	1912	1911	1912
					Gallons.	*Gallons.*	° *Baumé.*	° *Baumé.*
Brooke	4	5	5	7	1.5–8.0	2.0– 4.0	87 –94	85 95
Calhoun	1	1	1	1				
Hancock	1	2	1	3				
Harrison	1	1	2	1	1.0–5.0	0.7– 4.0	83.2–92	82–90
Marion	1	1	1	1				
Marshall	1	1	1	1				
Pleasants	10	16	13	18	2.0–2.5	1.0– 4.0	75 –91	70–92
Ritchie	5	14	7	14	1.5–4.6	1.0– 4.0	83.2–96	78–96
Tyler	16	14	34	40	1.5–9.0	1.9–11.0	79 –95	80–92
Wetzel	2	2	2	2	1.5–3.0	1.5– 2.75	80 –89	80–88
Wirt	1	1	1	1				
Wood	4	8	4	8	1.0–4.5	2.0– 4.0	87 –89	82–95
Total	47	66	72	97	[a] 2.92	[a] 2.8	.....	.....

[a] Average.

PENNSYLVANIA.

Pennsylvania, which was second in the quantity of gasoline produced from natural gas in 1912, takes third place in 1913, having been displaced by Oklahoma. It will be noted that there were more gasoline producers in Pennsylvania in 1913 than in any other State, also that the number of plants in operation was 113, as compared with West Virginia, which had 115; but that the production of West Virginia

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was more than twice as much, the average daily capacity of the plants in Pennsylvania being much smaller. Producers in Pennsylvania not having compressor plants but using the gas-pump or vacuum process are not included in the table under the head of "Plants in operation." Their production, however, is included and amounted to a considerable output in 1913.

The following table shows that Butler County produced more gasoline from natural gas in 1913 than any other county in the State, or a total of 944,009 gallons, followed by Warren County, whose production was 838,006 gallons. Next in order of production are McKean, Allegheny, Venango, and Forest counties.

In the following table is given the production of gasoline from natural gas in Pennsylvania in 1913, by counties:

Production of gasoline from natural gas in Pennsylvania in 1913, by counties.

County.	Plants.		Gasoline produced.		Average yield in gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
	Number in operation.	Daily capacity.	Quantity.	Value.		
		Gallons.	*Gallons.*		*Gallons.*	° *Baumé.*
Butler	52	4,986	944,009	$99,587	1–6	58–110
Warren	27	3,480	838,006	92,488	1–6	70– 96
McKean	10	7,298	573,466	69,179	2–4.5	86– 95
Allegheny	11	2,367	568,041	62,246	1.8–6	80– 90
Venango	5	1,345	265,982	24,293	1–4	70– 93
Forest	3	1,475	255,773	30,424	1.1–2.5	86– 90
Washington					6	87
Potter	5	1,256	234,819	26,969	1.25	84– 86
Greene					1.5	75
Crawford					1	80
Total	113	22,207	3,680,096	405,186	2.68	.....

In the following table is given the yield of natural gas in gasoline in Pennsylvania in the years 1911 and 1912, by counties:

Yield of natural gas in gasoline in Pennsylvania in 1911 and 1912.

Location of plant.	County.				Yield in gasoline per thousand cubic feet of gas.		Average gravity of gasoline as produced and before blending.	
	Number of operators.		Number of plants in operation.					
	1911	1912	1911	1912	1911	1912	1911	1912
					Gallons.	*Gallons.*	° *Baumé.*	° *Baumé.*
Allegheny	2	4	4	9	2.4–6.0	1.5–6.0	86– 87	82– 87
Armstrong	1	1	1	1	2.0	2.0	86– 88	86– 88
Butler	16	29	19	36	1.0–6.0	1.0–7.0	75– 93	74– 95
Forest	1	1	1	1	2.0–2.5	2.0–2.5	86– 88	86– 90
McKean	2	5	2	5	2.0–4.0	2.5–4.0	86– 88	85– 90
Potter	.....	1	.....	1	.....	1.0	.....	86
Venango	1	2	1	2	3.0–6.0	3.0	75– 90	[a] 58– 88
Warren	19	25	20	26	1.0–3.0	2.0–7.0	76–100	74–105
Washington	1	1	2	2	6.0	6.0	87	87
Total	43	69	50	83	[b] 2.8	[b] 2.8	.....	.....

[a] Drips. [b] Average.

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OHIO.

Ohio ranks fifth in the production of natural-gas gasoline in 1913, the production amounting to 2,072,687 gallons, valued at $112,404, with 41 plants in operation, as compared with 1,718,719 gallons, valued at $173,421, and 43 plants in operation, in 1912, an increase of 353,968 gallons in quantity and of $38,983 in value. Two plants in this State were idle the entire year 1913 on account of shortage of gas.

The following table shows that the largest production of gasoline in Ohio was from Monroe County, which produced 1,489,490 gallons in 1913, which was more than half the product of the State in that year. The next county in point of production was Washington, with a production of 298,748 gallons. The other gasoline-producing counties of this State in 1913 were Jefferson, Columbiana, Hancock, Fairfield, and Morgan.

The average yield per thousand cubic feet in gasoline of gas in Ohio in 1913 was 2.79 gallons.

In the following table is given the production of gasoline from natural gas in Ohio in 1913, by counties:

Production of gasoline from natural gas in Ohio in 1913, by counties.

County.	Plants.		Gasoline produced.		Average yield in gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
	Number in operation.	Daily capacity.	Quantity.	Value.		
		Gallons.	*Gallons.*		*Gallons.*	° *Baumé.*
Monroe	24	5,187	1,489,490	$156,184	½–5	84–97
Washington	10	1,330	298,748	29,444	1½–3	80–92
Jefferson	2	600			4–5.6	.....
Columbiana	2	250			3	92–96
Hancock	1		284,449	26,776		
Fairfield	1	775			2–2½	85–88
Morgan	1					
Total	41	8,142	2,072,687	212,404	2.79	.....

In the following table is given the yield of natural gas in gasoline in Ohio in the years 1911 and 1912, by counties:

Yield of natural gas in gasoline in Ohio in 1911 and 1912.

Location of plant.	County.				Yield in gasoline per thousand cubic feet of gas.		Average gravity of gasoline as produced and before blending.	
	Number of operators.		Number of plants in operation.					
	1911	1912	1911	1912	1911	1912	1911	1912
					Gallons.	*Gallons.*	° *Baumé.*	° *Baumé.*
Athens	1	(a)	1	(a)	5.0	(a)	.....	(a)
Columbiana	2	2	2	2	3.0–5.0	3.0– 7.0	88–91	85–94
Fairfield	1	1	1	1	2.0	1.5– 2.5	85–88	85–88
Jefferson	1	1	1	1				
Monroe	7	10	17	26	0.5–9.0	0.5–10.0	70–95	78–90
Morgan	2	2	3	3	2.0–2.5	2.0– 2.5	80–88	80–88
Washington	12	9	14	10	1.0–9.0	1.5– 9.0	80–95	80–92
Total	26	25	39	43	[b] 3.57	[b] 2.98	.....	.....

[a] Idle. [b] Average.

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OKLAHOMA.

Oklahoma ranks second in production of natural-gas gasoline in 1913, and the industry made greater progress than in any other State. The production was four times as much as in 1912, or 6,462,968 gallons, valued at $577,944, as compared with 1,575,644 gallons, valued at $99,626, in 1912; and the production in 1912 was four times greater than in 1911, which was 388,058 gallons, valued at $20,975. The table of production, by States, shows that 40 plants in operation in Oklahoma at the close of 1913 had a total daily capacity of 61,633 gallons, nearly twice the capacity of 115 plants in operation in West Virginia. As some of the plants in Oklahoma were erected during 1913 and were in operation for only a portion of that year and as additional plants have since been in course of erection, the indications are that Oklahoma will have a very much larger production to report for 1914.

It is not possible to give the gasoline production of this State by counties, but it may be said that Creek County leads in production, having produced in 1913 some 4,000,000 gallons, or nearly two-thirds of the production of the entire State, followed by Nowata County with over 1,500,000 gallons. The other producing counties are as follows, being named according to output: Muskogee, Tulsa, Pawnee, Okmulgee, and Washington.

The companies which have plants of largest capacity in Oklahoma are Chestnut & Smith and the Oklahoma Petroleum & Gasoline Co., both operating in Creek and Muskogee counties, and the Henderson Gasoline Co., operating in Nowata County; this company began operations in May, 1913. Other companies which began operations in 1913 are the Consumers Refining Co., Crosbie & Gillespie, the Gypsy Oil Co., and the Quaker Oil & Gas Co., in Creek County; Hull-McCune Co., in Tulsa County; the National Products Co., in Pawnee County; and the Riverside Western Oil Co., in Okmulgee County. Other companies having plants building in 1913 or 1914 are the Atlas Gasoline Co., in Creek County; the Chicago Oil Products Co., in Okmulgee County; the Cushing Gasoline Co., in Creek County; the Golden Gasoline Co., in Washington County; and the Motor Gasoline Co., in Muskogee County.

Gas produced from oil wells in many of the fields of Oklahoma is very rich in gasoline the reported gasoline content ranging from half a gallon to 8 gallons per thousand cubic feet of gas, the average for the State in 1913 being 3 gallons, the highest average yield reported for Oklahoma since the beginning of operations. The highest average yield is reported for Nowata County.

The report shows a gain in the average price per gallon received for gasoline in 1913 as compared with 1912, the average price being 8.94 cents in 1913 and 6.3 cents in 1912. The price ranged in 1913 from 7 to 12½ cents per gallon.

CALIFORNIA.

In progress of the natural-gas gasoline industry, California was second only to Oklahoma in the year 1913, its production having been three and one-half times as great as in 1912. The quantity of gasoline produced in 1913 was 3,460,747 gallons, valued at $376,227, as compared with 1,040,695 gallons, valued at $112,502, in 1912. The number of plants in operation at the close of 1913 was 14, with

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a total daily capacity of 21,135 gallons, as compared with 7 plants in operation in 1912 with a total daily capacity of 6,669 gallons.

The gasoline plants of this State are located in Orange, Santa Barbara, and Los Angeles counties. The oil wells of these counties produce large quantities of gas, far more than can be used for field operations, and much of this gas has gone to waste in past years. As this gas is very rich in gasoline, the establishment of plants for the extraction of gasoline from this excess gas is both economically and financially beneficial to the producers in this vicinity, as there has been a ready sale for all the gasoline produced. The average price received for gasoline in 1913 was 10.87 cents per gallon, there being no change since 1912.

In 1912 there was but one plant in operation in Orange County, that of the Pacific Gasoline Co. in Brea Canyon district. During 1913 this county made a gain of three plants, as follows: Brea Gasoline Co., 1 plant in Brea Canyon district; Hurley, Smith & Collins Co., 1 plant at Oleo station; and the Olinda Gasoline Co., 1 plant at Olinda. All the plants in this county were in operation in 1913, although one was in operation about three months and another five months, so that the production in 1914 may be largely increased. The production of gasoline in this county in 1913 was a little over one-third of the production of the State. In Santa Barbara County the following plants were in operation in 1912: Pinal-Dome Oil Co., 1 plant; Purity Gasoline Co., 2 plants; Union Oil Co., 1 plant; and Western Gasoline Co., 1 plant; all these companies began operations during the last half of 1912. In 1913 the following plants were added to the number in operation in this county: American Gas Co., 1 plant; Pinal-Dome Oil Co., 1 plant; and the Union Oil Co., 1 plant, a total of 8 plants in operation at the close of 1913. The largest production of gasoline in 1913 came from Santa Barbara County, the output being 1,953,643 gallons. Other gasoline plants in this State are the Columbia Oil Producing Co., 1 plant formerly operated by the Puente Oil Co., and the Standard Oil Co., 1 plant; both of these plants are located in Los Angeles County and were in operation in 1913. An experimental plant was operated near Fillmore, in Ventura County, by the Montebello Oil Co. in 1913. This company is installing a large unit at the present time. It will be seen that the gasoline industry in this State is in a flourishing condition, with greater prospects for the future.

The yield in gasoline per thousand cubic feet of gas used in California in 1913 ranged from 1 to 4 gallons, with an average yield of 1.42 gallons.

ILLINOIS.

The number of plants producing natural-gas gasoline in Illinois increased from 4, with a daily capacity of 1,400 gallons, in 1912, to 12, with a daily capacity of 6,250 gallons, in 1913. The production of this State being 581,171 gallons in 1913, a very substantial gain over 1912. The probabilities are that there will be a further increase in 1914, since some of these plants were in course of erection in 1913 and were in operation only a portion of that year.

The gasoline plants are located in Crawford and Lawrence counties. The yield of gas in gasoline ranged from 1½ to 6 gallons per thousand cubic feet in 1913, the average for the State being 3.6 gallons.

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COLORADO.

There has been no change in the condition of the natural-gas gasoline industry in Colorado since the last report. There are only two plants in the State, located in Boulder County, both of which were operating in 1913, the statistics of their production being included with those of other States.

NEW YORK.

Reports received from natural-gas gasoline producers in New York give a small production in 1913. There are three plants in this State—1 near Richburg, Allegany County, and 2 at Carrollton and Four Mile, Cattaraugus County. The oil wells of these counties produce considerable gas said to be rich in gasoline. The probabilities are that this State will continue to increase its gasoline production. One of the companies reporting was in operation but a short time in 1913, but is operating more fully in 1914. The "exhaust" gas is used for drilling and pumping and for domestic consumption.

KANSAS.

For the first time the State of Kansas appears as a producer of natural-gas gasoline. There was one producer in this State in 1913, the Vulcan Oil & Gas Co., which has a plant located in Chautauqua County and uses gas from its own wells. It is reported that another plant is in course of erection in this county.

The production of natural-gas gasoline in Kansas in 1913 is included with that of other States.

GASOLINE EXPORTS AND IMPORTS.

The exports of gasoline from the United States during 1913 amounted to 117,728,286 gallons, valued at $17,418,777; the imports amounted to 12,110 gallons, valued at $1,661.

The quantity of gasoline exported from the United States from July 1, 1912, to December 31, 1912, amounted to 38,070,949 gallons, valued at $4,671,815, and the quantity of gasoline and naphtha imported into the United States during the same period of time was 570 gallons, valued at $118.

ANALYSES OF NATURAL GAS FOR GASOLINE CONTENT.

Through the courtesy of the Bessemer Gas Engine Co., of Grove City, Pa., some analyses are given of natural gas from different localities of the country, with a brief explanation of the method of analysis as carried on in the laboratory of the company to estimate the gasoline content of natural gas. The gas analyses were made by R. A. Bastress and the physical tests by E. W. Jordon, both of the Bessemer Gas Engine Co.

All estimates of the gasoline content are based upon two-stage compression at 250 pounds. Estimates of yield are understood as the marketable product.

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Analyses of natural gas for gasoline content.

Analysis No.	Date of analysis.	Location of field.	Absorption heavy hydrocarbons.	Carbon dioxide.	Oxygen.	Nitrogen.	Specific gravity.	Combustion ratios.			R.	R′.	Gallons per thousand cubic feet of gas.
								Contraction.	CO_2.	O_2.			
			Per cent.										
2500	Apr. 2, 1913	Calgary, Alberta, Canada	15	None.	None.	None.	0.67	2.17	1.26	2.37	1.72	0.390	Dry.
2430	Jan. 25, 1913	Electra, Tex	50	None.	None.	None.	1.12	2.56	2.03	3.59	1.26	.889	3.5
2242	May 20, 1912	Oilfields, Cal	36	17.0	0.70	3.8	.79	2.21	1.13	2.34	1.96	.403	1.0
2747	Nov. 17, 1913	Casper, Wyo	45.1	None.	None.	None.	1.04	2.57	1.98	4.54	1.29	.806	3.0
2748	....do	....do	35.5	None.	None.	None.	.94	2.47	1.72	3.19	1.44	.653	2.0
1477	Feb. 23, 1911	Glenn Pool, Okla	62.5	4.7	.80	3.0	1.16	2.62	2.15	3.77	1.22	.951	4
2181	Jan. 2, 1912	Childers, Okla	79.3	None.	None.	None.	1.37	2.89	2.55	4.43	1.13	1.20	5.5
2065	July 17, 1911	Bremen, Ohio	25.0	None.	.30	(a)	.67	2.09	1.10	2.19	1.98	.338	Dry.
D45	Oct. 17, 1911	Cherrydale, Kans	21.2	.95	None.	None.	.60	2.03	1.01	2.04	2.00	.300	Dry.
2533	Apr. 28, 1913	Titusville, Pa	49.2	1.50	None.	None.	.90	2.48	1.64	3.13	1.51	.596	2
1632	Mar. 18, 1911	Sistersville, W. Va	45	.70	6.90	28.3	1.52	2.82	2.89	4.72	.976	1.56	Air-free.
1186	Jan. 26, 1910	....do	62.0	None.	2.5	(a)	1.23	2.72	2.24	3.95	1.21	1.02	4.5
1494	Feb. 23, 1911	Kiefer, Okla	68.6	3.90	None.	None.	1.30	2.66	2.19	3.85	1.21	1.07	.5
2478	Mar. 1, 1913	Charleston, W. Va	22	None.	None.	None.	.74	2.24	1.29	2.54	1.73	.427	5
A-1-5	Feb. 10, 1910	Grove City, Pa	15	None.	None.	None.	.63	2.04	1.02	2.06	2.00	.315	Dry.

a Not determined.

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Brief explanation of the methods of analysis and estimation.—Absorption is made in Elliott's gas burette, with claroline oil, a heavy, high-flash and burning-point oil as solvent. With 80 cubic centimeters of methane the absorption was found to be 15 per cent, approximately. Gas taken from high-grade natural-gas gasoline was practically soluble.

R and R′ are empirical, arbitrarily chosen constants. R is the result of dividing contraction by CO_2; R′ is the result of dividing specific gravity by R. Thus by comparison of analyses of gases whose gasoline content is known we are able to estimate very closely the yield of an unknown gas.

The following are physical tests made by the Bessemer Gas Engine Co. with Bessemer equipment on some gas which corresponds to that sent in for chemical analysis. These physical tests serve as check on the accuracy of the chemical analysis.

Analysis 2747: Chemical analysis shows 3 gallons. Physical test, suction pressure, 2.1 inches mercury; terminal pressure, 250 pounds; gross quantity of gasoline obtained, 3.83 gallons at 92° Baumé gravity per thousand cubic feet of gas; evaporation, 18.2 per cent; result, 3.13 gallons net of gasoline at 87° Baumé gravity per thousand cubic feet of gas.

Analysis 2748: Chemical analysis shows 2 gallons. Physical test, suction pressure, 4 pounds; terminal pressure, 250 pounds; gross quantity of gasoline, 2.45 gallons at 87° Baumé gravity, per thousand cubic feet of gas; evaporation, 16.6 per cent; result, 2.04 gallons net of gasoline at 84° Baumé gravity per thousand cubic feet of gas.

Analysis 2065 shows dry gas by chemical analysis. Physical test shows less than one-half gallon net of gasoline per thousand cubic feet of gas at 400 pounds compression.

CARBON BLACK.

The use of natural gas for the manufacture of carbon black has been so generally condemned as a waste that possibly the general public has lost sight of the fact that lampblack and carbon black are just as necessary products as any others obtained in the natural-gas industry; and that there is no source from which carbon black can be obtained with less waste than from natural gas, where it is not possible to use the natural gas for any higher purpose. As a matter of fact, in the regions where carbon black is now manufactured this utilization of gas is probably well justified. The carbon black can be manufactured from natural gas wastefully or with great relative efficiency, according to the methods employed. Thus far the Government reports have contained no general description of these methods; therefore, a condensation is given below of a very complete description of the manufacture of lampblack and carbon black, written by Godfrey L. Cabot,[1] of Boston, Mass. The principal features of his description follow:

In the American trade the term "lampblack" is usually understood to be a soot deposited by the smudge process and made from oil, resin, or some other solid or liquid raw material, whereas "carbon black" is the term applied to a black deposited by actual contact of a flame upon a metallic surface.

[1] Eighth Int. Cong. Appl. Chemistry, vol. 12, pp. 13 et seq.

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If the name "lampblack" be taken in its wider sense as meaning any commercial form of soot, it may be prepared in three different ways: First, by the combustion of dead oil of tar, pitch, resin, or some other carbonaceous raw material with an inadequate supply of air and the collection of the floating particles of soot that escape unburned from the flame and slowly deposit themselves on the walls and floors of the collecting chambers; second, it may be formed by the direct impact of a flame upon a collecting surface; and, third, it may be formed by heating carbonaceous vapors to a decomposing point, apart from air or flame.

If lampblack be restricted to the sense in which it is known to the American trade of a commercial soot deposited by the smudge process, the starting point of its manufacture is usually the dead oil of tar, an oil containing a large proportion of naphthalene, a certain proportion of phenol, and various aromatic hydrocarbons particularly suited to the manufacture of lampblack by reason of the large percentage of carbon therein contained. When this dead oil of tar is burnt with an inadequate supply of air, a very considerable proportion—to wit, from 15 to 35 per cent of its weight—can be obtained in the form of lampblack by decomposition in suitably arranged chambers. The quality of the black is determined by the size and shape of the furnaces in which the oil is burned, by the heat to which it is subjected in the process of manufacture, by the position in which the black is deposited, and by the care that is exercised in the process of manufacture and in the selection and preparation of the raw materials.

The oil is usually allowed to flow in a sluggish stream into an earthenware or iron pot or pan, in which it burns and from which the smoke passes through flues into the chambers in which it is deposited.

To absorb and utilize commercially some of the heat, boilers are often placed within reach of the flame and the steam thus generated is used for the industrial processes that may take place in the same factory. Care is necessary to free entirely from water whatever raw material may be employed and also to protect the reservoirs and the pipes from them to the burners from excessive cold, which might cause a stoppage by the coagulation of naphthalene, anthracene, or other solid matter in the pipes. A screen is often used at the final exit from the black-condensing chambers in order to hold back the last traces of the black, both on account of its value and because the smoke that passes from a lampblack factory is very annoying to neighbors.

The best grades of black, in general, are obtained in furnaces of moderate size, so built that the black is practically calcined at the time it is deposited and carries down with it but very little empyreumatic matter. The products of combustion are usually carried through a series of chambers and the black is assorted according to its distance from the point of origin, the lightest being that farthest from the flame and for this reason commanding better prices for certain purposes.

These chambers are periodically emptied, preparatory to which, it is needful to be sure that the black is thoroughly cold and is not afire, for it sometimes happens, if too much oxygen comes into the chambers, that the black gets afire and the fire may lurk undetected,

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unless great care be exercised. An experienced workman can usually detect fire by the smell, and the workmen are thus put on their guard to hunt out and extinguish the fire. It sometimes happens that the quantity of carbonic-oxide gas is dangerous to the workmen, and this danger should be borne in mind. This gas is very poisonous.

It has been observed that the smokiness of a flame can be increased by artificial cooling; for example, if a coarse wire grating is brought into an ordinary gas flame, the flame immediately begins to smoke, and various attempts have been made to utilize this principle to increase the yield of lampblack.

It is good practice to introduce partition walls in the chambers used for deposition, thereby increasing the distance that the products of combustion must travel before they finally escape into the open air, with a view to increasing the percentage of deposition; but this practice can easily be overdone, for if the chambers are divided up too much more harm is done by increasing the speed with which the products of combustion travel than good by increasing the distance.

Mechanical devices have been used in the form of stirrers, which churn the air and cause the condensation of the smoke in masses sufficiently large for it to deposit itself. The writer cited does not know whether any of these devices are now in use on a commercial scale. The soot thus obtained contains about 80 per cent of carbon, the rest being chiefly oxygen and hydrogen, with traces of grit on the walls and floors of the collecting chambers and a greater or less percentage of oil or other empyreumatic matter.

This oil or other empyreumatic matter can be driven off by heating the lampblack in sheet-iron boxes, care being taken, on the one hand, to heat it sufficiently to drive off the oil, and, on the other, not to make it so hot as to affect the mixing strength. Moreover, it is possible, as already stated, by a proper proportioning of the fireplace, flues, and the supply of raw material and a proper arrangement of the temperature and other conditions, to cause a deposition of a certain proportion of black practically free from empyreumatic matter from the start.

Resin, resinous woods, tar, pitch, and other raw materials have been and still are, to a certain extent, used in the manufacture of lampblack; but in general the quality of the black thus obtained is less good than that obtained from the dead oil of tar and other distillates, and such inferior raw materials are comparatively unimportant as a commercial source of lampblack.

Another method of making lampblack is by the heating of hydrocarbon vapors out of contact with air, a typical instance of which is set forth in patent No. 866883, by Albert D. Purtle and Irving E. Rowland, of Salem, W. Va. For years a similar process was used to extract carbon from natural gas to be used in the manufacture of electric-light pencils, near Red Bank, Pa.; but the carbon thus obtained cost too much to compete in the long run with coke, which is now the chief raw material for these pencils. Lampblack thus obtained is apt to contain particles of adamantine carbon, so hard that they will scratch glass. Another commercial obstacle is the high cost of the apparatus and the large expense from deterioration as compared with the value of the finished product. Therefore, although a much larger proportion of carbon can be obtained from

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natural gas by this than by any other known process, all such efforts have, up to this time, failed to show a commercial profit; but it is believed that this method of making carbon black will some time be successfully applied.

Attempts have been made, first, to volatilize the raw material and, second, to burn the resulting vapor on the smudge system with an insufficient supply of air and to collect the resulting soot; but it is not known that any such attempts have proved profitable on a commercial scale, and it is hardly believed that they would.

Various devices have been adopted to perfect the separation of the soot from the air, and it may be said that, both in the manufacture of lampblack by the ordinary smudge process and in the manufacture of carbon black by the contact process, one of the most difficult problems is the proper separation of the black from the air in which it floats or which it holds mechanically when it settles. In the case of the smudge process, adjustable blinds made of iron are sometimes used by which the black enters the chimney and which can be worked just like the adjustable slats on an ordinary window blind. Thus the draft is regulated and eddies are formed which help to cause the black to unite into larger pieces and to settle out. High-pressure electric discharges of a static machine have been used experimentally for causing this separation of the black from the air, but this is a too expensive and cumbersome method to prove profitable on a commercial scale, and, of course, on a large scale high-pressure discharges are dangerous. The best material for the chambers in which the black settles is masonry with cement floors and a brick roof put together with cement mortar.

When a new plant is put into operation, the black first made is apt to contain moisture condensed by the coldness of the walls, empyreumatic matter, which has not been calcined out for the same reason, and grit, which at first comes off the walls to an annoying extent, even when great care is exercised in construction. This first black is sold, usually at a cheap price, to those who are willing to use a black containing grit. Only after the operation has been carried on for some time, so that everything is warm and in good running order and the loose grit has fallen, can the best results as to quality be obtained.

The lampblack which is thus precipitated can be freed from empyreumatic matter by calcining, as already stated, or by washing with alkali or acid. So far as known, practically none of it is ever washed with alkali or acid, the expense of drying being very material. The handling of black is, in general, a difficult and expensive process, owing to its great bulk and extreme lightness, which cause a great deal of loss and much dirt and disagreeable work. It is more and more the aim of lampblack manufacturers so to conduct their process that the black is calcined in the process of making, at least, to an extent satisfactory to most buyers.

In the case of carbon black, the black when first scraped from the plates is so light that 30 pounds will fill a sugar barrel. When it is considered that the specific gravity of carbon black is about 1.7 (that is, very much heavier than water), it is perceived that 95 per cent of the bulk of black as it comes from the plates is air, and the problem of packing is to separate this black from the air so far as is commercially feasible. This can be done by screw packers, similar to

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those used for packing flour, but different in detail and run at a very much lower rate of speed; or it can be done by a plunger, lined with sheepskin, the wool side out, worked up and down vertically by a ratchet or screw. An essential element is time. The process of packing carbon black can not be hurried without much loss by the spurting of the black through the air, and many other evils.

As the black comes on the market, a sugar barrel will hold from 75 to 80 pounds. In fact, it is possible to get 80 pounds into a barrel of less than sugar-barrel size; which means that the black has been compressed to about one-third of its original bulk and that still about 88 per cent of its bulk is air. Under these conditions the black is very hard, and many buyers insist on its being packed under less pressure, owing to the consequent greater difficulty of grinding; but its ultimate quality for most uses is not affected by this pressure.

There is still another source of lampblack, to wit, acetylene gas obtained from the refuse of carbide of calcium factories, namely, those grades containing too little carbide of calcium to be merchantable. This acetylene gas possesses the remarkable quality of exploding by itself without the admixture of air, and Jaenecke & Schneemann manufactured black by exploding this gas under five atmospheres, either by compression or by an electric spark. The difficulty is, first, that the process is very hard on the apparatus, and, second, that the black thus obtained is very inferior in color and strength to carbon blacks from natural gas. It is essentially a by-product; the supply is very uncertain, and the price is irregular, but always averages much higher than that of carbon black. Therefore, it can only be used where its bluish tinge gives it the preference in certain trades.

"Carbon black" is the trade name given in this country, and to a certain extent abroad, to lampblack made upon the surfaces of metal or stone by direct impact of flame.

The first carbon black made and sold in this country in a commercial way seems to have been produced in the year 1864 by J. K. Wright, of Philadelphia, Pa., for use in the manufacture of printing ink. This industry is, therefore, a comparatively new one in this country, and it certainly never attained any great importance abroad, although it is not possible to state when carbon black was first made in other countries. Mr. Wright revolved sheet-iron cylinders over jets of artificial gas, and the black was removed from the cylinders by stationary scrapers. This process was used by other ink makers also; and a very glossy, high-priced ink, of intense color, was obtained.

These pioneers in the carbon-black industry apparently did not consider the process of sufficient importance to patent it, for the first patent granted in this country was issued December 10, 1867, to A. Millochan, of New York, for a process which proved to be of no value; and it was not until the year 1872 that any process was patented that was subsequently used on a regular commercial scale. The attention of many people, among others of Peter Neff, of Gambier, Ohio, and John Howarth, of Salem, Mass., had been attracted to the fact that large quantities of natural gas going to waste in the gas regions offered a cheap and abundant raw material for this manufacture, and on September 17, 1872, John Howarth received a patent for the manufacture of carbon black from natural carburetted hydrogen gas, claiming the production of carbon black from a natural carburetted hydrogen gas issuing from the earth, etc. His plan was to connect the

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gas well with a gas holder, such as is used in artificial gas works and provided with a blow-off from which might escape the surplus flow of the well not required in the process of manufacture. As the natural pressure of gas in the rock sometimes exceeded 500 pounds on the horizon from which he derived the supply of his factory, and as there was at that time no method of regulating the flow, this waste of gas was a necessary feature of his enterprise. From the gas holder the gas passed through pipe to ordinary gas jets arranged in the same horizontal plane beneath slabs of soapstone. These slabs of soapstone were provided with holes for ventilating, without which the carbonic-acid gas and other inert products of combustion would have formed a layer about the middle of the slabs and have kept the flame away from the surface, thereby diminishing the yield and impairing the color of the resulting product. Above these slabs of soapstone rose in an arch an iron dome or hood with a chimney at the top, and in this chimney a damper that could be set to give the right draft. On the slabs rested pans of water closed in and kept cool by a continuous circulation. The edges of this arch descended below the edges of the soapstone slabs and were grooved horizontally; in the grooves ran a scraper that could be pulled to and fro by hand. This scraper removed from time to time the deposited soot which fell into the sheet-iron aprons or troughs which hung from the burner pipe. From these again the black fell through discharge pipes into receptacles which could be changed by hand when full. This was a very crude, clumsy, and expensive way of making carbon black, decidedly less advantageous than that previously employed in making black from artificial gas, but, nevertheless, owing to the cheapness of the raw material, the price, which had been $3 to $5, immediately dropped to $2.50, then to $1.50, and shortly after to $1.25 a pound. It is, however, a curious fact that the black from natural gas does not possess all the qualities of that made from artificial gas.

On March 23, 1875, John Howarth received a further patent on a traveling car which hung from rails running lengthwise of the bench or row of slabs, and these rails also held between them the slabs themselves. This car carried a scraper, a shallow frame, and, hanging to that frame on each side, two deep receptacles of sheet iron, which could be detached at will and emptied. These receptacles were joined together over the burners by a narrow arch of sheet iron, just wide enough to allow the apparatus to pass over the single row of burners without striking. The car was drawn by an endless rope passing over pulleys and pulled first in one direction and then in the reverse. The scrapers were held against the plates by wire springs, and were only in contact with the plate when passing toward the end at which the receptacles were removed. The dome was a superfluous adjunct. Cast iron was better than soapstone and there was no need of water cooling. Indeed, Mr. Howarth never used water cooling on a commercial scale. Obviously, its effect would hardly be felt through such a nonconductor as soapstone. The first factory was located at New Cumberland, W. Va. The gas came from what is known as the salt sand, was very rich in carbon, and made an excellent black. The factory was made of wood, and before long it burned down and the business was removed to Saxonburg station, Pa.

In two or three years competition sprang up at Gambier, Ohio, where a small factory was erected by Peter Neff, who had made black by a somewhat similar process for 10 or 12 years. He had as

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many patents for carbon-black apparatus as all the other inventors put together, but most of them were fantastic and useless. His factory reached an output at one time of 125 pounds a day.

The next important competition was by A. V. Nolen, who, in the year 1879, built a factory at New Cumberland, W. Va., and made black on cast-iron pans holding water. By this time the price of black had gone down to about 60 cents a pound, but, nevertheless, whereas the two pioneers had met with little pecuniary success, Mr. Nolen, by superior ability, made a good deal of money, and bought out the original company.

Various other small factories were started from time to time, but it was not until the year 1883 that any considerable advance was made, when the firm of L. Martin & Co., of Philadelphia, Pa., became interested in a small and struggling enterprise at Fosters Mills, Pa., and there erected five plates 24 feet in diameter, cast in segments and suspended on a central mast, which rotated with them upon a bronze bedplate. Beneath this was fixed a stationary burner of parallel, horizontal iron pipe, 1¼ inches in diameter, branching from a central supply 3¾ inches inside diameter, and this, in turn, connected suitably with the well.

Incredible as it may seem, even at this time, after 10 years of experience, no attempt had been made by the three leading manufacturers to control the flow of gas from the wells, although this was then quite possible with available appliances, and a blazing torch at each gas well, wasting daily millions of feet, was a feature at the principal factories, including that at Fosters Mills, Pa.

About the same time a factory was started by Samuel Cabot in the adjacent village of Worthington, Pa., at which some efforts were made to confine and economize the gas, but it remained in large part fruitless for some years, owing to the inefficiency of the foreman.

At the factory at Fosters Mills the idea of a traveling box and scraper was discarded and the plan of a horizontally rotated collecting surface was for the first time successfully adopted on a commercial scale. The same principle was adopted at Worthington at about the same time, but failed of success, owing to purely mechanical imperfections. It would seem at first as if the original idea of moving only the scraper box was the correct principle; and yet it is now entirely abandoned, and about two-thirds of all the black that is made to-day is made on surfaces which are moved over a stationary scraper box and stationary burners.

The first decade of the manufacture of carbon black from natural gas on a commercial scale was the time of factories in which the collecting surfaces were arranged in rectangular shapes, placed end to end to form what the workmen call "benches." The details whereby the black was collected, the dimensions of the different parts, and the arrangements of the size of the burners varied in different factories; but four-fifths of all the black made was made on benches, and the rest was made on the external surfaces of rotating cylinders.

The year 1883 brought with it the introduction of large rotating plates, which replaced at Fosters Mills a factory in which benches had been used. A scraper box and scraper was placed radially so that in revolving the scrapers were at right angles to the direction in which the surfaces passed across them. The black was removed by a screw conveyor in the bottom of the scraper box which carried

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it outward to a longer conveyor, which in turn ran tangential to five plates in a row and carried the black to a rotating bolt, through which it went into the bin. It was then lifted from the bin by hand in large scoops and packed by hand with a screw press, but the black is very light and the handling of it was very dirty, unhealthy work, which involved also considerable loss in raw material. In the earlier factories it had been the habit to brush the black through a fine horizontal sieve by means of brushes rotating on a vertical axis. A bolt revolving on a horizontal axis which discharged the coarser particles of black at one end and allowed only the finer particles to fall through it was a decided improvement.

In the same year A. R. Blood, of Warren, Pa., devised a method in which a small plate about 3 feet in diameter was used. The advantage of this was that no ventilation holes were needed, as in the case of the larger plates, except, however, that this small plate was cast in the form of a ring with an opening in the center. This plate was moved by means of a ratchet at the center. This ratchet was worked by a lever, and this by another lever revolved on a shaft. Every time the shaft revolved the lever would give the plate a little shove, which would move it 1½ inches. Beneath the plate was a scraper in the mouth of a radial hopper, through which the black fell into a longitudinal conveyor running beneath the row of plates. There were 16 plates in a row and 5 rows in the building. The building was of sheet iron on a framework of pipe and angle iron and was pierced with small holes near the bottom to give the needful supply of air. Along the ridge pole was an opening about 30 inches wide, and about 6 inches above this was a little pent roof to prevent the entrance of rain, and through the space between the products of combustion passed. All of these factories used gas jets either of iron or steatite, such as are ordinarily used in houses. There was one factory which used Argand burners, but it did not last many years. About this same year, 1883, E. R. Blood, the father of A. R. Blood, began to make black on the roller process, using a burner with a small hole in the point of the tip which gave a round flame. This black was at first very unprofitable, owing to the small yield and the comparatively poor color, but the successors of A. R. Blood improved the details of manufacturing, and experience has shown this black to possess some valuable qualities, and in spite of its inferior color it sells for a high price and is very profitable to the owners, the Peerless Carbon Black Co., of Pittsburgh, Pa. This company was for many years the only company making carbon black in this country from natural gas on revolving cylinders, although in earlier days two or three factories used this principle, and there are now three such factories.

In the second decade the process of making carbon black introduced by A. R. Blood became the most important as to output and total value of black produced. The prices of black fell rapidly and reached 7 cents a pound by the year 1887 and 4 cents a pound by 1889. After this there was a considerable improvement in prices, followed by a further rapid increase in output, and by the close of the second decade the total output had reached about 10,000 pounds a day, worth at that time about 6 cents a pound.

Toward the end of the second decade two new processes began to become an appreciable factor in the total output. The first of these

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was the process of Mr. Cabot, whereby, under 24-foot plates, similar to those previously mentioned though varying somewhat in details, was rotated a burner and black box radially placed. The burner was made up of parallel 1¼-inch pipe inserted in a central supply pipe 3¾ inches in diameter. As first used the radial black box discharged into a hopper placed at the side of the plate by means of a little trapdoor with a lever which was pressed in such a way as to open the trapdoor every time it passed over the hopper; after the discharge the trapdoor closed again by means of a counterpoise. This method of rotating burner was introduced at Worthington about the year 1884, but did not become a commercial success until 1887. The factory changed hands, and the new owner changed the method to that of a central discharge whereby the black was continuously discharged downward by a vertical spout at the inner end of the radial black box into a circular box; thence it went through a hole in the bottom into a long conveyor. By the former method the long conveyor had been tangent to the ring, and by this method it went within 2 feet of the center. A cover was hung above this round box in such a way as to exclude air and rotate with the burners, black-collecting box, etc. The bottom of the vertical spout above alluded to pushed the black in front as it slowly swung around the ring until the black reached the orifice through which it fell. One great advantage of this method was that the black was not exposed to the air. By the former method whenever the box emptied, a cloud of black arose, causing annoyance and much loss of output. As rebuilt, the black was kept under cover and carried to a bolt, also shut in, and raised from beneath this bolt by an elevator into a bin. From this bin, it was packed by machinery in either sacks or barrels, always under cover, so that from the time the black was made until it was used by the consumer, it was never touched by hand and was always under cover and protected from all appreciable drafts of air.

The other process above referred to was introduced about the year 1891 at Gallagher, Pa., and consisted of a system of channel beams turned with flat side downward over horizontal rows of stationary burners and black boxes. By a reciprocating mechanism, these beams slowly moved back and forth and the black was scraped and removed by a screw conveyor in the usual manner. This black was packed direct without bolting. The chief advantage of this system is the perfection of the surfaces, which are smoother than the surfaces of cast-iron plates.

In the beginning of the third decade of this industry, another attempt was made to manufacture carbon black with the use of petroleum and under a somewhat new principle by evaporating petroleum and burning its vapors through gas burners. The cost of making this black was probably less than that of any other black made from petroleum by the contact process; still it was more than could be realized by its sale. One great difficulty was the formation of adamantine carbon in the black. These particles were so hard that they would scratch glass, and the manufacturer was unable to discover a method of removing them. Since that time there has been no carbon black made from oil on a commercial scale in this country, although there is a small quantity of a very expensive grade made in Europe from what are known as gas oils, heavy oils obtained in the distillation of shale and used chiefly by manufacturers of illuminating gas. No important improvement in making carbon black appeared

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in the third decade. The output steadily increased and reached 20,000 pounds a day.

The price fluctuated a good deal, the average for the decade (1893–1902) being about 6 cents. The output of black produced with rotating burners and with the reciprocating channel beams very considerably increased. There were also modifications made in the process of the small stationary plate, and the output made on this general principle increased. In 1902, about one-quarter of all the carbon black was made with rotating burners, about one-fifth with reciprocating channel beams, not quite one-half on rotating cast-iron plates, mostly with the smaller sizes, and the rest chiefly with rollers. There was only one factory in existence which operated on the bench principle.

In the year 1899 the construction at the Grantsville, W. Va., factory was begun, which used 24-foot plates, with revolving burners and black box, etc., beneath them. By the end of the third decade, namely, about the year 1902, this had become the largest factory in existence and has been still further increased until it is making about 10,000 pounds of carbon black a day. Possibly a brief description of this factory may be of interest. It lies on the right bank of Little Kanawha River and comprises 113 plates, each 24 feet in diameter and surrounded by protecting rings of corrugated iron 26 feet in diameter. Above these plates is a roof made partly of triangular sheets of sheet iron and partly of rectangular sheets of corrugated iron and reaching about two-thirds of the way to the top of the 16-foot mast on which these plates are hung, leaving, therefore, in the center a space having about one-third the diameter of the plate, through which the products of combustion can escape upward.

These plates are arranged in rows parallel to the river and disposed on two sides of a central avenue which runs from the river to the road, at right angles to both.

The black is collected by long conveyors running through the center of the rows of plates toward the central avenue; here it passes into larger conveyors, which bring it to the packing house and elevate it into bins; from them the black is packed partly by sack packers and partly by barrel packers, which work with a plunger.

The black is carried down Little Kanawha River in gasoline boats. Large tanks, containing about a thousand barrels of water, stand on the hillside above the factory, and the factory is adequately piped in every part over an area of about 6 acres, whereby water can be turned on, either for the purpose of putting out fire or for the purpose of knocking black out of the ventilator holes in the rings on which the black is deposited.

These rings are of two patterns: One of them is made with 14 radial arms in the shape of T rails, which support 70 cast-iron plates, 5 between each pair of arms. The other pattern has for each plate 48 segments, 16 in the inner row and 32 in the outer row, which are supported directly by guys. In each case the plate is supported by guys screwed into a cap, which has approximately the shape of a very blunt, truncated cone. This cap rests upon the top of the hollow mast and the joint between the cap and the mast is made good with asbestos board. The mast stands in a bedplate on the upper surface of which is a groove, in which run 1½-inch steel balls. Upon these steel balls rests a casting having 8 horns, which project outward and upward and are fixed in the lower ends of struts made of 2-inch pipe. On the outer end of these struts of 2-inch pipe is an

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angle casting into which the 2-inch pipe fits and through which a horizontal hole accommodates a horizontal guy rod, attached at the inner end to an octagonal plate, which rotates with the burner around the central mast. On the outer end of these horizontal guy rods are ¾-inch nuts, and by screwing these up the struts can be raised to the correct position, thus regulating the height of the burners beneath the plate. On the face of these angle castings supported by the 2-inch struts is bolted an iron bar, which hangs vertically down from these angle castings, and to this iron bar is attached an angle iron, in which runs the chain that rotates the burners, black box, etc. Against these angle castings is also bolted a horizontal ring, made of bars 4½ by ½ inch and forming a circle around the plate, and on this ring is supported the gridiron of burner pipe. This gridiron of burner pipe has as its central supply a piece of 3¾-inch casing, 22 feet 6 inches long, and this casing, in its turn, is fed with gas by 2½-inch pipes, connected with the help of 4 ells and a union to an octagonal gas box, at the top and bottom of which sit glands. This gas box is fed through holes in the mast. The glands are stuffed with asbestos so that the gas can not escape as the carbon black box revolves around the mast.

The black is removed from the plates by scrapers placed radially to the mast above the box; in the bottom of the box lies a screw conveyor, which in its turn is actuated by a pinion on its inner end, and this pinion engages a bevel fixed to the central mast. Beneath the octagonal plate, to which the horizontal guys are fastened, is bolted a hanger in which turns the shaft of the conveyor which carries the pinion just mentioned. On the inner end of the box the black descends in a vertical 3-inch pipe through the rotating cover into the circular box from which it discharges downward into the long conveyor, which runs tangent to this circular box and 2 feet from the center of the ring.

In the last decade certain new processes have come into use which are, however, only modifications of those mentioned. In one factory, namely, that of the Bristol Oil & Gas Co., of West Virginia, the black is collected on a hollow channel iron, flat beneath, through which a blast of air is blown, with a view of cooling the plates.

The question is often asked whether the heat of the gas used in the manufacture of carbon black is saved or lost, and why. It is always lost, and for the reason that the expense of utilizing this heat would greatly exceed the value of the power to be obtained. The Grantsville works, producing about 10,000 pounds of black a day, are operated by 5 gas engines, which probably do not consume 50 cents worth of gas a day at the price at which gas is bought at this plant. If these works were in the immediate vicinity of a large city it is probable that it would pay to circulate water underneath them in an immense coil and to heat the neighboring quarter of the city with hot water. Located as they are in a sparsely settled country, 30 miles from the railroad terminus, there is no practical way of saving this heat. Wasteful as this operation seems, it is better than that all of this gas or a great part of it should pass into the atmosphere through the numerous oil wells of the Yellow Creek and other adjoining fields.

Another source of waste in this manufacture is the smoke, which ascends day and night to a very great height in the atmosphere and can sometimes be seen at a distance of 18 miles, but this consists of lampblack rather than carbon black and would probably only sell

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for 2 or 3 cents a pound if it could be collected, and the task of collecting even one-half of it would probably be much more expensive than the whole maintenance of the factory and its fuel supply.

The total value of carbon black made in a year would somewhat exceed $1,000,000, and the total annual value of the world's output of lampblack would probably be two or three times as much; but the real importance of these two commodities to humanity is inadequately represented by these figures.

They form the basis of the black printing inks, with which all our printing is done, and they are also largely used in black paints, for stove polish, and for coloring rubber, oilcloth, leather, and many other substances too numerous to mention,

It is rather a curious fact that the use of carbon black and of lampblack are separately defined, and quite sharply defined at that; so that the market price of each commodity fluctuates with little reference to the market price of the other.

Carbon black is much better for black ink, stove polish, and vulcanized rubber. Lampblack is much better for coloring oilcloth, leather, and other forms of rubber, and is much more widely used in paint, although carbon black is better for certain kinds of paint and varnish.

If a buyer is using a black made by the smudge process or by the heating or explosion of hydrocarbon vapors, he does not wish to change and to take the black made on the contact process; and if a buyer is using a black made on the contact process, he can not safely switch over to a black made on the smudge or the explosion process.

The gradual diminution of the margin between the cost of making black and the average selling price goes on, and there seems to be no reason why it should not continue through the present decade. There seems no likelihood, either, of any shortage of carbon black, except from some temporary cause, or of any great and permanent enhancement in the price during the life of any one now living.

CITIES AND TOWNS SUPPLIED WITH NATURAL GAS.

The following list contains the names of cities and towns in the United States which were either wholly or in part supplied with natural gas in the year 1913:

ALABAMA.

Fayette. Jasper. West Huntsville.

ARKANSAS.

Argenta.	Emmet.	Huntington.	Pulaski Heights.
Arkadelphia.	Fort Smith.	Little Rock.	Ravana.
Bauxite.	Garland.	Mabelvale.	Sheridan.
Benton.	Gifford.	Malvern.	Texarkana.
Bierne.	Gum Springs.	Mansfield.	Van Buren.
Boughton.	Gurdon.	Perla.	
Bryant.	Hope.	Pine Bluff.	
Donaldson.	Hot Springs.	Prescott.	

CALIFORNIA.

Alhambra.	Burbank.	Fairfield.	Huntington Park.
Athens.	Cement.	Fellows.	Longbeach.
Arroyo Grande.	Compton.	Gardena.	Los Angeles.
Bakersfield.	Cudahy.	Glendale.	Los Berros.
Betteravia.	Eagle Rock.	Guadaloupe.	Lynwood.

Digitized by Google

CALIFORNIA—continued.

Maricopa.
Moneta.
Nipomo.
Orcutt.
Oxnard.
Pasadena.
Redondo Beach.
Sacramento.
San Fernando.
San Gabriel.
Santa Maria.
Santa Monica.
Santa Paula.
Sawtelle.
South Pasadena.
South Taft.
Stockton.
Suisun City.
Taft.
Torrance.
Tropico.
Venice.
Ventura.
Vernon.

COLORADO.

Boulder.

ILLINOIS.

Annapolis.
Birds.
Bridgeport.
Carlinville.
Casey.
Duncanville.
East Chicago.
Eaton.
Flat Rock.
Greenville.
Heyworth.
Hutsonville.
Lawrenceville.
Marshall.
Martinsville.
New Hebron.
Oblong.
Olney.
Palestine.
Pinkstaff.
Porterville.
Robinson.
Stoy.
Sumner.

INDIANA.

Adams.
Albany.
Alexandria.
Anderson.
Arcadia.
Atlanta.
Batesville.
Cambridge.
Carmel.
Carthage.
Charlottesville.
Chesterfield.
Cicero.
Clarksburg.
Connersville.
Converse.
Cowan.
Daleville.
Downeyville.
Dublin.
Dunkirk.
Dunreith.
Eaton.
Elwood.
Falmouth.
Farmland.
Fortville.
Fountaintown.
Frankton.
Freeport.
Geneva.
Gentryville.
Germantown.
Gowdy.
Greenfield.
Greensburg.
Gwynneville.
Hagerstown.
Hartford City.
Herbst.
Homer.
Honey Creek.
Hope.
Hortonville.
Kennard.
Knightstown.
Kokomo.
La Fontaine.
Letts.
Lewisville.
Loogootee.
McCordsville.
Manilla.
Marion.
Markleville.
Maxwell.
Mays.
Middletown.
Mier.
Milford.
Millgrove.
Millhousen.
Milroy.
Milton.
Modoc.
Mohawk.
Montpelier.
Morristown.
Mount Auburn.
Mount Summit.
Muncie.
Newcastle.
New Lisbon.
New Point.
Noblesville.
Oaklandon.
Oakland City.
Oakville.
Ovid.
Pendleton.
Pennville.
Portland.
Powers.
Princeton.
Raleigh.
Raysville.
Redkey.
Richmond.
Ridgeville.
Rushville.
St. Paul.
Sandusky.
Sardinia.
Sharpsville.
Shelbyville.
Sheridan.
Shirley.
Spiceland.
Springport.
Straughn.
Sullivan.
Sweetsers.
Tipton.
Union City.
Vincennes.
Waldron.
Warrington.
West Liberty.
Westport.
Williamstown.
Winchester.
Windfall.
Winslow.

KANSAS.

Altamont.
Altoona.
Arkansas City.
Atchison.
Augusta.
Baldwin City.
Bartlett.
Bassett.
Baxter Springs.
Benedict.
Bonner Springs.
Bronson.
Buffalo.
Burlington.
Caney.
Carlyle.
Chanute.
Chautauqua Springs.
Cherokee.
Cherryvale.
Chetopa.
Coffeyville.
Colony.
Columbus.
Cottonwood Falls.
Coyville.
Deerfield.
Earleton.
Edgerton.
Edna.
Edwardsville.
Eldorado.
Elk City.
Elk Falls.
Elmdale.
Elsmore.
Empire City.
Emporia.
Erie.
Eudora.
Eureka.
Fairhaven.
Fall River.
Fort Scott.
Fredonia.
Galena.
Gardner.

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KANSAS—continued.

Garnett.
Gas.
Greeley.
Havana.
Hepler.
Howard.
Humboldt.
Hutchinson.
Independence.
Iola.
Jefferson.
Kansas City.
La Harpe.
Lawrence.
Leavenworth.
Lenexa.
Liberty.
Merriam.
Moline.
Moran.
Mound City.
Mound Valley.
Neodesha.
New Albany.
Newton.
Niotaze.
North Altoona.
Olathe.
Osawatomie.
Oswego.
Ottawa.
Paola.
Parsons.
Peru.
Pittsburg.
Pleasanton.
Princeton.
Rantoul.
Richmond.
Roper.
Rose.
Savonburg.
Scammon.
Scipio.
Sedan.
Shawnee.
Spring Hill.
Stanley.
Strong.
Sycamore.
Tonganoxie.
Topeka.
Turner.
Tyro.
Vilas.
Weir.
Welda.
Wellington.
Wellsville.
Wichita.
Winfield.
Yates Center.

KENTUCKY.

Ashland.
Barbourville.
Bellevue.
Buchanan.
Burning Springs.
Caney.
Cannel City.
Catlettsburg.
Central City.
Clifton.
Cloverport.
Cold Spring.
Covington.
Dayton.
Diamond.
Dunmor.
Greenup.
Hazel Green.
Inez.
Kenner.
Kavanaugh.
Lewisburg.
Lexington.
Louisa.
Louisville.
Ludlow.
Maysville.
Mount Sterling.
Newport.
Paintsville.
Paris.
Pollard.
Rothwell.
Russell.
Russellville.
Salyersville.
Warfield.
West Covington.
West Liberty.
West Point.
Winchester.

LOUISIANA.

Belcher.
Blanchard.
Dixie.
Hoeston.
Ida.
Lewis.
Mansfield.
Mooringsport.
Mystic.
Oil City.
Rodessa.
Shreveport.
Vivian.

MARYLAND.

Corinth.
Cumberland.
Deer Park.
Frostburg.
Loch Lynn.
Lonaconing.
Luke.
Mountain Lake Park.
Oakland.
Western Port.

MISSOURI.

Belton.
Carl Junction.
Carterville.
Carthage.
Joplin.
Kansas City.
Martin City.
Nevada.
Oronogo.
Rich Hill.
St. Joseph.
Webb City.
Weston.

NEW YORK.

Addison.
Akron.
Alden.
Alexander.
Alfred.
Alfred Station.
Allentown.
Almond.
Ambush.
Amherst.
Andover.
Angelica.
Angola.
Armor.
Attica.
Baldwinsville.
Batavia.
Belfast.
Belmont.
Blasdell.
Bolivar.
Bowmansville.
Brant.
Bristol.
Bristol Center.
Brocton.
Buffalo.
Caledonia.
Canisteo.
Cattaraugus.
Ceres.
Chipmonk.
Churchville.
Clarence.
Clarence Center.
Collins.
Collins Center.
Corfu.
Corning.
Crittenden.
Cuba.
Deer Creek.
Depew.
Dunkirk.

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NEW YORK—continued.

East Aurora.
East Bloomfield.
East Hamburg.
East Pembroke.
Ebenezer.
Eden.
Elma.
Elmira.
Evans.
Farnham.
Forestville.
Fredonia.
Friendship.
Gangloff.
Gardenville.
Genesee.
Getzville.
Gorham.
Gowanda.
Greenwood.
Hamburg.
Hanover.
Holcomb.
Holland.
Honeoye Falls.
Hornell.
Independence.
Irving.
Jamestown.
Jewettville.
Lacona.
Lackawanna.
Lancaster.
Le Roy.
Lima.
Limestone.
Millgrove.
Montour Falls.
Mumford.
Naples.
North Collins.
North Tonawanda.
Obi.
Olean.
Orchard Park.
Pavilion.
Perry.
Petrolia.
Phoenix.
Pomfret.
Portland.
Portville.
Pulaski.
Reserve.
Rexville.
Richburg.
Ripley.
Rushville.
Salamanca.
Sandy Creek.
Scio.
Sheridan.
Silver Creek.
Southport.
Springville.
Stanards.
Tonawanda.
Town Line.
Versailles.
Warsaw.
Watkins.
Webb Mills.
Wellsville.
West Bloomfield.
West Clarksville.
Westfield.
West Phoenix.
West Seneca.
Wheatland.
Williamsville.
Wyoming.
Zoar.

NORTH DAKOTA.

Lansford.

OHIO.

Academia.
Ada.
Adelphi.
Akron.
Alexandria.
Alger.
Alliance.
Amanda.
Amboy.
Amesville.
Amherst.
Amsterdam.
Andover.
Antioch.
Appleton.
Arcanum.
Arlington.
Ashland.
Ashtabula.
Ashville.
Athens.
Austinburg.
Avery.
Bairdstown.
Baltimore.
Bangs.
Barberton.
Barlow.
Barnesville.
Bartlett.
Basil.
Batesville.
Beach City.
Beallsville.
Beem City.
Bellaire.
Belle Valley.
Belleville.
Bellevue.
Belmont.
Beloit.
Belpre.
Berea.
Bergholz.
Berlin Heights.
Bethany.
Bethesda.
Bettsville.
Beverly.
Bexley.
Birmingham.
Bladensburg.
Bloomdale.
Bloomingburg.
Bowerston.
Bowling Green.
Bratenahl.
Bremen.
Bridgeport.
Brilliant.
Brink Haven.
Buckeye City.
Buckeye Lake.
Buchtel.
Buckingham.
Bucyrus.
Buffalo.
Bullett Park.
Burbank.
Burgoon.
Butler.
Byesville.
Cadiz.
Caldwell.
Cambridge.
Canal Dover.
Canal Winchester.
Canfield.
Canton.
Cardington.
Carey.
Carroll.
Carrollton.
Cedarville.
Celina.
Centerburg.
Chatham.
Chauncey.
Chesterhill.
Chicago.
Chillicothe.
Chippewa Lake.
Cincinnati.
Circleville.
Clarington.
Claysville.
Clearport.
Cleveland.
Cleveland Heights.
Clintonville.
Clyde.
Coal Grove.
Coal Run.
Coalton.
Cochransville.
Coldwater.
Columbiana.
Columbus.
Conneaut.
Corning.
Coshocton.
Covington.
Crestline.
Creston.
Cridersville.
Crooksville.
Croton.
Cuyahoga Falls.
Cygnet.
Dakes.
Danville.
Dayton.
Deavertown.
Delaware.
Dennison.
Derwent.
Dexter City.
Doylestown.
Drakes.
Dresden.
Dudley.
East Cleveland.
East Fultonham.
East Liverpool.
East Palestine.
Eaton.
Edison.
Elba.
Elmore.
Elyria.
Empire.
Enterprise.
Euclid.
Euphemia.
Findlay.
Florence.
Flushing.
Fly.
Forest.
Fort Recovery.
Fostoria.
Franklin.

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OHIO—continued.

Frazeysburg.
Fredericktown.
Fremont.
French Creek (Avon).
Fulda.
Fultonham.
Gahanna.
Galena.
Galion.
Gallipolis.
Gambier.
Geneva.
Genoa.
Germantown.
Gibsonburg.
Girard.
Glenroy.
Glouster.
Gore.
Grandview.
Granville.
Graysville.
Greenville.
Grogan.
Groveport.
Guysville.
Hallsville.
Hamden.
Hamilton.
Hanging Rock.
Hannibal.
Hanover.
Hanoverton.
Harlem Springs.
Harpster.
Harriettsville.
Hayesville.
Hebron.
Hemlock.
Homer.
Homeworth.
Hooker.
Hopedale.
Horns Mills.
Howard.
Hubbard.
Huntsville.
Ironton.
Jackson.
Jackson Center.
Jacksontown.
Jacksonville.
Jefferson.
Jeromesville.
Jerusalem.
Jewett.
Johnstown.
Jolly.
Junction City.
Kansas.
Kent.
Kenton.
Kilgore.
Kilbuck.
Kingston.
Kingsville.
Kirkersville.
Lakeside.
Lakewood.
Lancaster.
Laurelville.
Leesville.
Leetonia.
Leonard.
Leroy.
Lewisburg.
Lewisville.
Lexington.
Lima.
Linden.
Lisbon.
Litchfield.
Lockville.
Lodi.
Logan.
London.
Lorain.
Loudonville.
Lowell.
Lowellville.
Lower Salem.
McArthur.
McConnellsville.
Macksburg.
Malaga.
Malta.
Mansfield.
Maria Stein.
Marietta.
Marion.
Martinsburg.
Martins Ferry.
Massillon.
Maumee.
Medina.
Mendon.
Miamisburg.
Middleport.
Middletown.
Milan.
Millersburg.
Millersport.
Millers Run.
Millwood.
Milo.
Miltonsburg.
Mineral City.
Mingo.
Minster.
Monroe.
Monroeville.
Montezuma.
Morral.
Morristown.
Mount Gilead.
Mount Liberty.
Mount Sterling.
Mount Vernon.
Mount Victory.
Moxahala.
Murray.
Nashport.
Negley.
Nelsonville.
Neptune.
Nevada.
New Albany.
New Alexandria.
Newark.
New Athens.
New Berlin.
New Boston.
New Bremen.
Newburgh.
New Carlisle.
New Castle.
Newcomerstown.
New Hagerstown.
New Knoxville.
New Lexington.
New Matamoras.
New Middletown.
New Philadelphia.
Newport.
New Riegel.
New Springfield.
New Straitsville.
Niles.
North Amherst.
North Baltimore.
North Georgetown.
North Hampton.
North Kingsville.
North Lima.
Norwalk.
Nottingham.
Oakharbor.
Oberlin.
Orrville.
Osgood.
Outville.
Ozark.
Pataskala.
Pennsville.
Perrysburg.
Perrysville.
Petersburg.
Pickerington.
Piqua.
Pleasant City.
Pleasantville.
Plymouth.
Point Pleasant.
Poland.
Polk.
Pomeroy.
Portage.
Portsmouth.
Quaker City.
Ravenna.
Rendville.
Reno.
Rex Mills.
Reynoldsburg.
Richmond.
Rockbridge.
Rock Creek.
Rockyridge.
Roseville.
Roxbury.
Rural.
Rushville.
St. Clairsville.
St. Henry.
St. Louisville.
St. Marys.
Salem.
Salineville.
Sandusky.
Sarahsville.
Sardis.
Scio.
Sciotoville.
Sebring.
Senecaville.
Seville.
Shadyside.
Sharon.
Shawnee.
Shelby.
Shepard.
Sherodsville.
Shreve.
Sidney.
Simons.
Somerset.
Somerton.
South Charleston.
South Olive.
South Zanesville.
Spencer.
Spencerville.
Springfield.
Stafford.
Sterling.
Steubenville.
Stewart.
Stockport.
Stoutsville.
Strasburg.
Struthers.
Sugar Creek.
Sugar Grove.
Summerfield.
Sunbury.
Sycamore.
Tarlton.
Texas.
Thornville.
Thurston.
Tiffin.
Tippecanoe City.
Tiro.
Toledo.
Toronto.
Tremont City.
Trimble.
Trinway.
Troy.

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OHIO—continued.

Uhrichsville.
Upper Sandusky.
Urbana.
Utica.
Vanburen.
Vincent.
Wadsworth.
Wapakoneta.
Warner.
Warren.
Warsaw.
Washington Court House.
Washingtonville.
Waterford.
Watertown.
Waterville.
Wellington.
Wellston.
Wellsville.
West Alexander.
West Bedford.
West Carrollton.
Westerville.
West Jefferson.
West Lafayette.
West Manchester.
West Millgrove.
West Rushville.
West Salem.
Wheelersburg.
Whipple.
Wilberforce.
Williamsport.
Woodsfield.
Wooster.
Worthington.
Youngstown.
Xenia.
Zanesville.
Zenz City.

OKLAHOMA.

Arcadia.
Ardmore.
Avant.
Bartlesville.
Beggs.
Bigheart.
Bixby.
Blackwell.
Bluejacket.
Boynton.
Braman.
Bristow.
Broken Arrow.
Cameron.
Chandler.
Chelsea.
Choteau.
Claremore.
Cleveland.
Coalton.
Collinsville.
Copan.
Coweta.
Cross.
Cushing.
Davenport.
Dawson.
Delaware.
Depew.
Dewar.
Dewey.
Drumright.
Duncan.
Dustin.
Edmond.
Eufaula.
Gotebo.
Guthrie.
Hallett.
Haskell.
Hattonville.
Henryetta.
Inola.
Jenks.
Jennings.
Kellyville.
Kiefer.
Kildare.
Lawton.
Lenapah.
Luther.
Marlow.
Meeker.
Miami.
Midlothian.
Morris.
Mounds.
Muskogee.
Newkirk.
Nowata.
Ochelata.
Oglesby.
Okewah.
Oklahoma.
Okmulgee.
Oologah.
Osage.
Owasso.
Pawhuska.
Ponca.
Porter.
Poteau.
Pryor.
Ramona.
Red Fork.
Sand Springs.
Sapulpa.
Shawnee.
Skiatook.
South Coffeyville.
Stroud.
Terlton.
Tonkawa.
Tulsa.
Turley.
Vinita.
Wagoner.
Wainwright.
Wann.
Welch.
Wellston.

PENNSYLVANIA.

Aliquippa.
Altoona.
Alverton.
Ambridge.
Apollo.
Argentine.
Arnold.
Austin.
Avalon.
Avonmore.
Baden.
Barnes.
Beallsville.
Beaver.
Beaver Falls.
Belle Vernon.
Bellevue.
Bingham.
Blackstown.
Blairs Corners.
Blairsville.
Bloomster.
Bluff.
Bolivar.
Bowerton.
Boyers.
Bradford.
Bradys Bend.
Branchton.
Brockport.
Brockwayville.
Brookville.
Brownsville.
Bruceton.
Bruin.
Bryant.
Buena Vista.
Buffalo.
Bullion.
Bully Hill.
Burgettstown.
Butler.
Cabot.
California.
Callensburg.
Callery.
Campbelltown.
Candor.
Canonsburg.
Carnegie.
Carnot.
Carrick.
Carrolltown.
Castle Shannon.
Cecil.
Centerville.
Ceres.
Charlerei.
Chicora.
Clairton.
Clarendon.
Clarendon Boro.
Clarington.
Clarion.
Claysville.
Clermont.
Clintonville.
Cochranton.
Colegrove.
Coleville.
Colona.
Connellsville.
Conoquenessing.
Conway.
Cooksbur.
Cooperstown.
Coraopolis.
Corry.
Corsica.
Coryville.
Coudersport.
Courtney.
Craigsville.
Cresson.
Crosby.
Curllsville.
Darlington.
Davistown.
Dawson.
Dayton.
Derrick City.
Derry.
Donora.
Dubois.
Duke Center.
Dunbar.
Dunkard.
East Brady.
East Hickory.
Easton.

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PENNSYLVANIA—continued.

East Sharon.
East Springfield.
Edgeworth.
Edinburg.
Eidenau.
Elbon.
Eldersville.
Eldred.
Elizabeth.
Elkland.
Ellwood City.
Emlenton.
Emporium.
Emsworth.
Endeavor.
Enon Valley.
Enterprise.
Erie.
Evans City.
Fairmount City.
Fairview.
Falls Creek.
Farrell.
Fayette City.
Finleyville.
Florence.
Ford City.
Fosters Mills.
Foxburg.
Franklin.
Fredonia.
Freedom.
Freeport.
Frogtown.
Fryburg.
Galeton.
Garland.
Gastonville.
Genesee.
Geneva Hill.
Gibsonton.
Gill Hall.
Gilmore.
Ginger Hill.
Girard.
Glade Run.
Glassport.
Glendale.
Glenfield.
Glenhazel.
Glen Osborne.
Glenwillard.
Grand Valley.
Grapeville.
Great Belt.
Greenfield.
Greensburg.
Greenville.
Grove City.
Guitonville.
Hackett.
Hadley.
Halsey.
Harmony.
Harpers Corners.
Harrisville.
Hawthorn.
Haysville.
Hazel Hurst.
Heidelburg.
Herman.
Hickory.
Highland.
Hilliards.
Hillsville.
Holbrook.
Homer.
Homer City.
Hooker.
Hopwood.
Houston.
Hydetown.
Imperial.
Indiana.
Industry.
Ingomar.
Instanter.
Irvineton.
Irwin.
James City.
Jamestown.
Jeannette.
Jefferson.
Johnetta.
Johnsonburg.
Johnstown.
Jollytown.
Kane.
Kane Boro.
Kane City.
Karns City.
Kaylor.
Keisters.
Kellettsville.
Khedive.
Kinzua.
Kittanning.
Knoxville.
Kushequa.
Lamont.
Langloth.
Larabee.
Latrobe.
Leechburg.
Leeper.
Leesburg.
Leetsdale.
Lickingville.
Ligonier.
Limestone.
Lucinda.
McClellandtown.
McDonald.
McKees Rocks.
McKinley.
Manor.
Manorville.
Marble.
Marianna.
Marienville.
Mars.
Marvindale.
Marwood.
Masontown.
Mayburg.
Meadow Lands.
Meadville.
Mercer.
Middle Fork.
Midland.
Millers Eddy.
Millport.
Monaca.
Monessen.
Monongahela.
Monterey.
Mount Alton.
Mount Jewett.
Mount Morris.
Mount Oliver.
Mount Pleasant.
Myonia.
Natrona.
Nedskey.
New Bethlehem.
New Brighton.
New Castle.
New Florence.
New Galilee.
New Kensington.
New Mayville.
New Salem.
New Sheffield.
New Stanton.
Newton.
Newtown Mills.
New Wilmington.
Noblestown.
North Blackville.
North East.
North Girard.
Norwich.
Oakdale.
Oakland.
Oak Ridge.
Oil City.
Ormsby.
Osgood.
Oswayo.
Otto.
Parkers Landing.
Petersville.
Petroleum Center.
Petrolia.
Philipston.
Pittsburgh.
Pittsfield.
Pleasantville.
Plummer.
Point Marion.
Polk.
Pollock.
Port Allegany.
Porter.
Portersville.
Poseytown.
Primrose.
Prospect.
Punxsutawney.
Queen.
Queenstown.
Ratigan.
Redman.
Red Rock.
Reidsburg.
Renfrew.
Reno.
Reynoldsville.
Ridgway.
Rimer.
Rimersburg.
Rixford.
Rochester.
Rockland.
Rogersville.
Rolfe.
Roscoe.
Roseville.
Roulette.
Rouseville.
Rural Valley.
Rynd Farm.
St. Marys.
St. Petersburg.
Salina.
Salem.
Saltsburg.
Sandy Lake.
Saxonburg.
Scottdale.
Semples.
Seneca.
Sewickley.
Sharon.
Sharon Center.
Sharpsville.
Shawmut.
Sheffield.
Shinglehouse.
Shinglehouse Boro.
Sligo.
Slippery Rock.
Smethport.
Smiths Ferry.
Snowden.
South Brownsville.
South Heights.
South Sharon.
Spring Church
Stoneboro.
Straight.
Strattonville.
Sturgeon.
Sugar Creek.
Summerville.
Tarentum.
Tarrs.
Taylorstown.
Tidal.
Tidioute.

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PENNSYLVANIA—continued.

Tiona.	Venetia	Westfield.	Whiskerville.
Tionesta.	Venus.	West Freedom.	Whitetown.
Titusville.	Vides.	West Hickory.	Wick.
Townville.	Volant.	Westline.	Widnoon.
Troutman.	Walkers Mills.	West Middlesex.	Wilcox.
Turtle Creek.	Waltersburg.	West Middletown.	Wilkinsburg.
Tylersburg.	Warren.	West Monongahela.	Wilson.
Uniontown.	Warren Boro.	West Monterey.	Wireton.
Upper Middletown.	Washington.	West Newton.	Woodlawn.
Utica.	Waters.	West Sunbury.	Worthington.
Vanderbilt.	Waynesburg.	West Winfield.	Youngsville.
Vandergrift.	West Alexander.	Wetmore.	Youngwood.
Vanport.	West Elizabeth.	Wheatland.	Zelienople.

SOUTH DAKOTA.

Fort Pierre.	Pierre.

TEXAS.

Albany.	Cass.	Gainesville.	Petrolia.
Alvord.	Corsicana.	Grand Prairie.	Queen City.
Arlington.	Crowther.	Henrietta.	Rhome.
Atlanta.	Dallas.	Irving.	Sherman.
Bangs.	Dalworth.	Laredo.	Sunset.
Bellevue.	Decatur.	Leigh.	Teague.
Bloomburg.	Denison.	Marshall.	Texarkana.
Bowie.	Denton.	Mexia.	Whitesboro.
Bridgeport.	Eagle Ford.	Moran.	Wichita Falls.
Byers.	Fort Worth.		

WEST VIRGINIA.

Adamston.	Center Point.	Fairview.	Hurricane.
Alma.	Centerville.	Farmington.	Hutchinson.
Arvilla.	Ceredo.	Farnum.	Jacksonburg.
Barboursville.	Charleston.	Finch.	Jacksonville.
Barrackville.	Chelyan.	Flat Woods.	Janelew.
Belington.	Chester.	Flemington.	Jarvisville.
Belmont.	Clarington.	Follansbee.	Kenova.
Bens Run.	Clarksburg.	Fort Gay.	Kermit.
Benwood.	Clendenin.	Friendly.	Keyser.
Benson.	Coalburg.	Fulton.	Kygar.
Beraman.	Colfax.	Gandeeville.	Lima.
Big Isaac.	Colliers.	Gassaway.	Littleton.
Big Springs.	Corinth.	Gay.	Logan.
Blacksville.	Crawford.	Glen Dale.	Longacre.
Blue Creek.	Creston.	Glen Easton.	Lost Creek.
Blueville.	Crown Hill.	Glenova.	Loudenville.
Boothsville.	Culloden.	Glenville.	Loveland.
Branchland.	Danville.	Glovergap.	Lumberport.
Bridgeport.	Davis.	Goose Creek.	McMechen.
Briscoe.	Daybrook.	Grafton.	Madison.
Bristol.	Deanville.	Grantsville.	Mahone.
Broad Oaks.	Dunbar.	Griffithsville.	Mannington.
Brookville.	Eastbank.	Hamlin.	Meadowbrook.
Buckhannon.	Edgewood.	Handley.	Metz.
Buffalo.	Elizabeth.	Hannahdale.	Middlebourne.
Burdett.	Elkins.	Hansford.	Miletus.
Burning Springs.	Ellenboro.	Harrisville.	Milton.
Burnsville.	Elm Grove.	Haymond Heights.	Monongah.
Burton.	Elm Run.	Haywood.	Montgomery.
Cairo.	Enterprise.	Heaters.	Monticello Add.
Cameron.	Erie.	Hepzibah.	Morgantown.
Cannelton.	Eureka.	Hundred.	Moundsville.
Cedargrove.	Fairmont.	Huntington.	Mount Clare.

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WEST VIRGINIA—continued.

Mount Zion.
Murphytown.
Myra.
New Cumberland.
New Martinsville.
Ogdin.
Ona.
Paden City.
Palestine.
Parkersburg.
Parsons.
Patterson.
Pennsboro.
Peoria.
Petroleum.
Philippi.
Piedmont.
Pine Grove.
Pleasant Valley.
Poca.
Point Pleasant.
Pratt.
Proctor.
Pruntytown.
Pullman.
Ravenswood.
Reedy.
Ripley.
Rockford.
Rowlesburg.
St. Albans.
St. Marys.
Salem.
Sandyville.
Schultz.
Sedalia.
Seth.
Sherrard.
Shiloh.
Shinnston.
Shirley.
Shrewsbury.
Silverton.
Simpson.
Sistersville.
Smithburg.
Smithers.
Smithfield.
Smithville.
South Buckhannon.
Spencer.
Spring Hill.
Star City.
Sutton.
Tanner.
Terra Alta.
Thornton.
Tyler City.
Wallace.
Walton.
Ward.
Warwood.
Waverly.
Wayne.
Wellsburg.
West Fork.
Weston.
West Union.
Wheeling.
Wileyville.
Williamson.
Williamstown.
Wilsonburg.
Woodlawn.
Woodsdale.
Woodville.
Worthington.
Wyatt.

WYOMING.

Basin.
Byron.
Greybull.

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II:35

DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

THE SOURCE, MANUFACTURE, AND USE OF LIME

By ERNEST F. BURCHARD AND
WARREN E. EMLEY

Mineral Resources of the United States, Calendar Year 1913—Part II
(Pages 1509–1593.)

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1914

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CONTENTS.

	Page.
Introduction	1509
Source of lime, by E. F. Burchard	1511
Limestone	1511
Classification	1511
Origin	1512
Character	1514
Varieties of limestone	1515
Varieties based on texture	1515
Fine-grained, dense limestone	1515
Nonmetamorphosed crystalline limestone	1515
Metamorphosed crystalline limestone (marble)	1515
Oolitic limestone	1516
Fossiliferous limestone	1516
Shell limestone	1517
Chalky limestone	1517
Conglomeratic limestone	1517
Cherty limestone	1517
Marl	1517
Travertine	1517
Stalactitic and stalagmitic limestone and onyx marble	1518
Varieties based on composition	1518
High-calcium limestone	1518
Magnesian limestone	1519
Dolomite	1519
Argillaceous limestone	1520
Arenaceous and siliceous limestone	1520
Gradations in limestone	1520
Impurities in limestone	1520
Structure of rocks	1521
General considerations	1521
Dislocations	1522
Joint	1522
Fault	1522
Folds	1522
Anticline, syncline, dip, and strike	1523
Monocline	1524
General characteristics	1524
Topographic expression	1524
Ages of rocks	1525
Time and stratigraphic subdivisions	1525
Formations	1525
Value of fossils	1525
Rock systems	1526
Thickness of sedimentary rocks	1526
Overburden	1527
Age and general distribution of limestones sampled	1527
General distribution of limestone in the United States east of the Rocky Mountains	1529
New England States	1530
Limestone, lime, and marble	1530
New York, New Jersey, and Pennsylvania	1531
Limestone and lime	1531
Marble	1532
Maryland, Delaware, Virginia, West Virginia, North Carolina, and South Carolina	1532
Limestone, lime, and marble	1532

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Source of lime, by E. F. Burchard—Continued.
General distribution of limestone in the United States east of the Rocky Mountains—Continued. Page.
Tennessee, Mississippi, Alabama, Georgia, and Florida ... 1533
Limestone and lime ... 1533
Marble ... 1533
Wisconsin and Michigan ... 1534
Limestone ... 1534
Illinois, Indiana, Ohio, and Kentucky ... 1535
Limestone ... 1535
Onyx marble ... 1537
Minnesota ... 1537
Limestone ... 1537
North Dakota ... 1539
South Dakota ... 1539
Limestone and lime ... 1539
Marble ... 1540
Iowa ... 1540
Limestone ... 1540
Nebraska ... 1541
Limestone ... 1541
Missouri ... 1542
Limestone ... 1542
Kansas ... 1543
Limestone ... 1543
Arkansas ... 1545
Limestone and marble ... 1545
Louisiana ... 1546
Limestone ... 1546
Oklahoma ... 1546
Limestone ... 1546
Marble ... 1547
Texas ... 1548
Limestone ... 1548
Marble ... 1549
Montana ... 1549
Limestone ... 1549
Marble ... 1550
Wyoming ... 1550
Limestone ... 1550
Marble ... 1550
Colorado ... 1550
Limestone ... 1550
Marble ... 1551
New Mexico ... 1552
Limestone ... 1552
Marble ... 1552
Western and Pacific coast States ... 1552
Character of lime produced in the various States ... 1552
Manufacture and Use of Lime, by Warren E. Emley ... 1556
General discussion ... 1556
Definition and classification of lime ... 1556
Manufacture ... 1557
Process of manufacture ... 1557
Quarries ... 1557
Quality of stone ... 1557
Chemical composition ... 1557
Physical properties ... 1558
Quarrying ... 1559
Stripping ... 1559
Drilling ... 1560
Blasting ... 1561
Sorting and loading ... 1562
Method of transportation ... 1562
Kilns ... 1563
Method and time of charging ... 1563
Kiln design ... 1564
Methods of operating kilns ... 1567

Digitized by Google

Manufacture and Use of Lime, by Warren E. Emley—Continued.
Manufacture—Continued.
Process of manufacture—Continued. Page.
Burning.... 1568
General discussion.... 1568
Methods of producing the draft.... 1570
Comparison of combustion economy.... 1572
Direct combustion.... 1572
Gas producers.... 1573
Hydrated lime.... 1575
Analyses.... 1575
Manufacture of hydrated lime.... 1576
Chemical and physical properties of lime.... 1579
Commercial packages.... 1580
Use of lime.... 1581
Building lime.... 1581
Mortar.... 1581
Lime and Portland cement.... 1582
Finishing lime.... 1583
Agricultural lime.... 1583
Chemical lime.... 1585
Sand-lime brick.... 1586
Glass.... 1586
Ceramics.... 1586
Water softening.... 1587
Soda ash and caustic soda.... 1587
Bleaching powder.... 1588
Calcium carbide.... 1588
Illuminating gas and ammonia.... 1588
Calcium cyanamide and calcium nitrate.... 1589
Spraying.... 1589
Sugar.... 1589
Distillation of wood.... 1590
Paper.... 1590
Paints.... 1591
Glycerine, lubricants, and candles.... 1591
Tanning.... 1591
Other uses.... 1592

ILLUSTRATIONS.

Page.
PLATE VIII. Reconnaissance map of principal limestone areas in the United States east of the Rocky Mountains.... 1510
IX. *A*. Jointed structure in horizontally bedded Niagara limestone, Drummond Island, Mich.; *B*. Outcrop of Chickamauga limestone beds near Ewing, Va., showing dip and strike.... 1522
FIGURE 22. Ideal sections of strata showing normal faults and a thrust or reverse fault.... 1522
23. Ideal diagram of a complete fault.... 1523
24. Section across folded strata showing anticline and syncline.... 1523
25. Diagram showing unsymmetrical overturned folds in marble strata at Lenox, Mass.... 1524

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THE SOURCE, MANUFACTURE, AND USE OF LIME.

By ERNEST F. BURCHARD and WARREN E. EMLEY.

INTRODUCTION.

In June, 1909, the United States Geological Survey, in cooperation with the National Lime Manufacturers' Association, began a study of lime. Both field and laboratory work were undertaken. In the field the conditions prevailing as to quarrying, handling, crushing, burning, and hydrating were studied, and samples of limestone, burned lime, and hydrated lime were collected from a wide territory embracing nearly all the States east of Missouri River and from quarries in various types of rock, grading from high-calcium to high-magnesium limestone. In collecting the samples the geologic formations in which the quarry was situated were noted, as well as the dip and strike of beds and the lithologic and structural features that might have a bearing on the quarrying and utilization of the stone. In the laboratory, which was situated at Pittsburgh, Pa., the work included chemical analyses and physical tests of the limestone and chemical and physical tests of quicklime and hydrated lime. The principal aim of the investigation is to show the effect of impurities contained in various limes, the effect of low and high temperatures on the quality of the lime burned, the different degrees of plasticity displayed by different limes, the strength of the lime mortars, and to determine, if possible, the best conditions for hydration. The work was carried on for about one year under the United States Geological Survey, but on July 1, 1910, the structural-materials laboratories at Pittsburgh were transferred to the United States Bureau of Standards, under which organization the work has been continued. During the early stages of the investigation the authors were associated in the field work; the laboratory work has been performed by W. E. Emley, of the Bureau of Standards. Some results have already been published by the Bureau of Standards and by the National Lime Manufacturers' Association, as indicated in the following list:

ASHLEY, H. E., The spreading and setting qualities of lime mortars: Nat. Lime Mfrs. Assoc. Trans., pp. 43–47, 1910.

BLEININGER, A. V., and EMLEY, W. E., The burning temperature of limestones: Am. Ceramic Soc. Trans., vol. 13, pp. 618–638, 1911. Also in Nat. Lime Mfrs. Assoc. Trans., pp. 68–78, 1911.

BLEININGER, A. V., The physical properties of lime: Nat. Lime Mfrs. Assoc. Trans., pp. 365–369, 1909.

EMLEY, W. E., Kiln design: Nat. Lime Mfrs. Assoc. Trans., pp. 90–107, 1910.

——— Some investigations on lime: Nat. Lime Mfrs. Assoc. Trans., pp. 48–50, 1910.

——— Tests of lime: Nat. Lime Mfrs. Assoc. Trans., pp. 192–199, 1911.

——— Lime: Its properties and uses: Bur. of Standards Circ. 30, 22 pp., 1911.

——— Manufacture of lime: Bur. of Standards Tech. Paper 16, 130 pp., 1913.

WIG, R. J., The use of hydrated lime in Portland cement mixtures: Nat. Lime Mfrs. Assoc. Trans., pp. 213–220, 1911.

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The publication of the present joint paper by the United States Geological Survey is in response to a continuous demand from correspondents for correlated information concerning limestone and lime. It has been the endeavor of the authors to furnish briefly the essential data needed by the prospective lime manufacturer as well as by the active manufacturer who desires a combined summary of the raw materials and of the recent developments in the lime industry. The data have been presented in as simple and nontechnical a manner as is consistent with clearness, and many definitions have been introduced in order to facilitate comprehension by the busy reader. In the chapters on the manufacture and use of lime the conclusions resulting from recent investigations have been stated without discussing to any considerable extent the experimental evidence on which they are based.

The introduction to Circular No. 30 of the Bureau of Standards on Lime: its properties and uses, is as follows:

> Lime has been used as a building material for centuries, but until recently very little exact information about its properties has deen obtainable. It has always been such a cheap commodity that the transportation cost was of more importance to the consumer than the quality of the lime. Recently the chemical industries have opened a new market for lime in which quality is of paramount importance, and contractors and builders have learned that low cost and cheapness are by no means synonymous. Therefore it has now become necessary to study the properties of lime with a view to drawing up standard specifications so that manufacturer and consumer will be enabled to reach an exact understanding. Such a study must include the distribution of economically available deposits of limestone, the methods of manufacture, the methods of testing lime, and the properties which the lime must have in order to satisfy the various consumers. The first two of these subjects will be treated more in detail in articles by Mr. Burchard and Mr. Emley shortly to be published by the United States Geological Survey and the United States Bureau of Standards respectively.

The present paper endeavors to fulfill the proposed work mentioned in the last part of the quotation.

In the chapter on the source of lime the author has borne in mind the desirability of presenting the elements of geology as related to the lime industry, and has endeavored to outline this field briefly and in an elementary manner through a discussion of such topics as follow: classification, origin, varieties, gradations, and impurities of limestone; rock structure; ages of rocks; formations; value of fossils; table of rock systems; thickness of sedimentary rocks, and overburden. A few diagrams are inserted which illustrate points discussed. The general distribution of limestones and marbles in the United States westward as far as the Rocky Mountain States is outlined by States or groups of States, and is illustrated by a general map which shows the areas in which high-calcium limestones predominate and those in which magnesian limestones predominate. This map (Pl. VIII is drawn to such a relatively small scale that it can not show very definite boundaries, and of course the areas which are indicated as underlain predominantly by limestone contain other rocks in places. Likewise there are many small areas of limestone that it has not been practicable to show on the map.

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SOURCE OF LIME.

By Ernest F. Burchard.

For the sake of clearness and at the risk of repeating certain statements that may be made in the chapter on the manufacture of lime it is thought best at the outset to define lime and to indicate its chemical composition in order that its derivation may readily be understood.

Chemically pure lime is the oxide of calcium (CaO), and contains by weight 5 parts of calcium and 2 parts of oxygen. It is chemically rather active. Therefore it is not found native, but always in combination with other substances. The most common substance that combines with lime is the gas, carbon dioxide (CO_2), forming calcium carbonate, according to the following reaction: Lime (CaO) + carbon dioxide (CO_2) → calcium carbonate ($CaCO_3$). Conversely, if calcium carbonate in any of its forms is broken up by heat, there is obtained as a result lime and carbon dioxide, according to the following reaction: Calcium carbonate ($CaCO_3$) + heat → lime (CaO) + carbon dioxide (CO_2).

Substances containing calcium carbonate, or, as it is more commonly termed, lime carbonate, such as limestone, calcite, marble, and oyster shells, are therefore the most common commercial sources of lime.

The chemical activity of lime is of interest as illustrating the cycle of changes that the material undergoes. When exposed to the air lime absorbs water or moisture and forms calcium hydroxide. Calcium hydroxide in turn absorbs carbon dioxide from the air and forms calcium carbonate and water. Thus, lime if exposed to the air will in time revert to a substance having the same chemical composition as the one from which it was derived. The reactions are as follows:

Lime (CaO) + water (H_2O) →calcium hydroxide ($Ca(OH)_2$).

Calcium hydroxide ($Ca(OH)_2$) + carbon dioxide (CO_2) → calcium carbonate ($CaCO_3$) + water (H_2O).

These reactions take no account of impurities nor of other substances associated with calcium carbonate in limestone. Limestone masses rarely are wholly composed of calcium carbonate, therefore the lime derived from these rocks is rarely pure. Certain of the more common impurities are silica, alumina, and iron oxides, and one other substance, magnesium carbonate, which behaves similarly to calcium carbonate and is nearly everywhere present in widely varying proportions. (See "Varieties of limestone," p. 1515.)

The chemical activity of lime forms the basis for the manufacture of lime products and for the many uses of lime and its products in the industries. The more important of these processes and uses, as well as the methods of manufacture of lime, will be indicated by Mr. Emley in succeeding sections of this paper.

LIMESTONE.[1]

CLASSIFICATION.

Limestone belongs to the class known as sedimentary rock as distinguished from igneous and metamorphic rocks. The lime manu-

[1] For data on limestone see various modern textbooks on geology, and the following special works:
Clarke, F. W., The data of geochemistry: U. S. Geol. Survey Bull. 491, 1911.
Crosby, W. O., Common minerals and rocks, D. C. Heath & Co., 1906.
Dale, T. N., Commercial marbles of western Vermont: U. S. Geol. Survey Bull. 521, 1912.
Kemp, J. F., Handbook of rocks, D Van Nostrand Co., 5th ed., 1911.
Merrill, G. P., Stones for building and decoration, John Wiley & Sons, 1903.
Pirsson, L. V., Rocks and rock minerals, John Wiley & Sons, 1909.
Van Hise, C. R., A treatise on metamorphism: U. S. Geol. Survey Mon. 47, 1904.

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facturer does not have to deal with igneous rocks at all; therefore they will not be considered here. True marble belongs to the class known as metamorphic rock. Sedimentary rocks are generally composed of the fragments or materials of older rocks of any class that have undergone disintegration on the surface of the land.

Metamorphic rocks are those sedimentary or igneous rocks which have, in the course of time, become greatly changed in composition and texture. The chief agents that bring about these changes are pressure, heat, and chemical reactions, generally at considerable depth below the surface of the earth. By metamorphic agencies limestone is transformed into marble. During the transformation the original bedding of the limestone may become nearly or completely obscured, and the crystalline texture and folded structure characteristic of marble are induced.

ORIGIN.

Sedimentary rocks have been deposited under water in seas and lakes, also on land surfaces, and in cavities and crevices in other rocks. The chief agent in the transportation of rock débris is water in motion, including rain water, streams, and the waves of the seas and lakes. Ice in motion in the form of glaciers and icebergs transports an important quantity of material, and the wind carries small quantities of very fine, light material. Where material is carried as solid particles, the deposits are said to be mechanical. Where the deposits are formed through the agency of organisms, they are called organic; such deposits include those formed by deposition from solution; if they are precipitated without the aid of organisms, they are called chemical deposits.

Calcium carbonate ($CaCO_3$), the principal compound in limestone, is slightly soluble in pure water, 1 liter of pure water solution at 8.7° C. containing 0.01 gram of the compound.[1] In water charged with carbon dioxide (CO_2), forming a solution of carbonic acid, calcium carbonate is more soluble, and forms calcium bicarbonate. These reactions are as follows:

$$\underset{\text{Water.}}{H_2O} + \underset{\text{Carbon dioxide.}}{CO_2} \rightarrow \underset{\text{Carbonic acid.}}{H_2CO_3}$$

$$\underset{\text{Carbonic acid.}}{H_2CO_3} + \underset{\text{Calcium carbonate.}}{CaCO_3} \rightarrow \underset{\text{Calcium bicarbonate.}}{CaH_2(CO_3)_2}$$

One liter of water saturated with carbon dioxide contains at 15° C. and zero partial pressure of carbon dioxide, 0.385 gram of calcium bicarbonate.[2] Under natural conditions, a less quantity is dissolved, but under pressure that exists at depths below the surface of the earth, water is believed to dissolve still greater quantities. Water sinking through the soil meets and dissolves carbon dioxide, which is constantly being given off from decaying vegetable matter. This acidulated water then takes up calcium carbonate from the soil and from the rocks through which it percolates. The water of streams is therefore constantly bringing a supply of dissolved calcium carbonate to

[1] Seidell, Atherton, Solubilities of inorganic and organic substances, p. 86. D. Van Nostrand Co., New York, 1907.
[2] Idem, p. 87.

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the ocean. Evaporation tends to concentrate this material in sea water, and were it not for the fact that large quantities of calcium carbonate are constantly being removed by the agency of organic life, as stated below, the sea water would become overcharged with this salt. One thousand parts of sea water contain about 34.40 parts, by weight, of mineral matter in solution. The proportions of the principal solids are shown in the following table:

Percentages of mineral salts in 100 parts of total solids contained in sea water.[1]

Sodium chloride (NaCl)	77.758
Magnesium chloride (MgCl)	10.878
Magnesium sulphate ($MgSO_4$)	4.737
Calcium sulphate ($CaSO_4$)	3.600
Potassium sulphate (K_2SO_4)	2.465
Magnesium bromide (MgBr)	.217
Calcium carbonate ($CaCO_3$)	.345
	100.000

Gases are also present in sea water, including a relatively large quantity of carbon dioxide, and these tend to increase the solvent power of the water toward calcium carbonate. There is no sharp line of distinction between chemical and organic deposits. The latter are really chemical in the broader sense of the term, but as their precipitation is immediately dependent upon living organisms, they are termed organic. Subaqueous inorganic chemical deposits are probably mostly formed in shallow water, and include (1) those due to evaporation of the water, and (2) those due to chemical reactions between solutions resulting in the precipitation of new and insoluble compounds.

Chemical deposits formed in shallow water are chiefly simple precipitates resulting from evaporation. All substances in solution are necessarily precipitated upon complete evaporation of the solvent, but since sea water rarely is saturated with its important salts, only a few are precipitated in quantities sufficient to be of geological importance. Where evaporation is incomplete, the principal deposits that are of interest in this connection are calcium carbonate ($CaCO_3$) (limestone) and calcium sulphate ($CaSO_4.2H_2O$) (gypsum); sodium chloride (NaCl) (rock salt); and chlorides and sulphates of potassium and magnesium.

The deposits of calcium carbonate, including shells and coral, have been very much greater than those of gypsum, because marine plants and animals extract calcium carbonate and not calcium sulphate from the water for their skeletons and shells, although there is more than ten times as much calcium sulphate as calcium carbonate in sea water. Calcium sulphate is more soluble in natural water than calcium carbonate, but rivers carry much more carbonate than sulphate to the sea since calcium carbonate is much more abundant on the land.

The secretion of lime carbonate by organisms does not depend on the quantity contained in the water, but may be carried on when the quantity in solution is very small. The principal deposits of calcium carbonate which have ultimately formed limestone have been made through the agency of plants and animals in the form of shells,

[1] From Dittmar, William, Narrative of the cruise of H. M. S. *Challenger*, vol. 1, pt. 2, p. 954, 1885.

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coral, bones, and teeth. Some of these deposits show more or less distinctly the fossil remains of the organisms which played so important a part in their formation, but others show no trace of their organic origin on account of the fineness to which the fragments were broken by the waves prior to their consolidation into rock masses. Although it is probable that the larger part of the calcium-carbonate deposits in the open sea are of organic origin, it is equally probable that in closed seas in which the conditions are favorable for concentration, precipitation may take place.

The purely chemical deposits of limestone are subject to solution, redeposition, and other changes, just as all other limestone deposits are. As a result, they often lose many of their original characteristics.

According to F. W. Clarke[1]—

> It is evident that important limestones may be formed in various ways, which, however, are chemically the same. Calcium carbonate, withdrawn from fresh or salt water, is laid down under diverse conditions, yielding masses which resemble one another only in chemical composition. An oceanic ooze may produce a soft, flourlike substance, such as chalk, or a mixture of carbonate and sand, or one of carbonate and mud or clay. Calcium carbonate, transported as a silt, may solidify to a very smooth fine-grained rock, while shells and coral yield a coarse structure, full of angular fragments and visible organic remains. Buried under other sediments, any of these rocks may be still further modified, the fossils becoming more or less obliterated, until in the extreme case of metamorphism a crystalline limestone is formed. All trace of organic origin has then vanished, a change which both heat and pressure have combined to bring about, aided perhaps by the traces of moisture from which ew rocks are free.

Sedimentary rocks are usually made up of layers or beds, which can be easily separated. These layers are called strata, and rock deposits in such layers are said to be stratified. The surface of the earth over wide regions is in slow motion. It very slightly rises or sinks with reference to the sea, and in this way shore lines are changed. As a result of upward movement of the earth's crust, marine and lacustrine sedimentary rocks may become part of the land, and in fact the greater part of the land area is occupied by rocks such as sandstone, shale, and limestone, which were originally deposited as sediments in the seas and in fresh-water lakes.

CHARACTER.

Limestone includes many and widely varying types of rock, differing in origin, color, texture, hardness, structure, and composition. The character of some of these various types will be taken up in connection with their probable origin. The one property they have in common is that of consisting largely of the mineral calcite (calcium carbonate, $CaCO_3$) or of the mineral dolomite, a combination of calcium and magnesium carbonates ($CaCO_3.MgCO_3$). No natural limestones are chemically pure, however, and few are nearly so. All contain more or less foreign material, either chemically combined or as admixed minerals. The more common of these foreign substances are magnesium carbonate ($MgCO_3$), ferrous carbonate ($FeCO_3$), ferrous oxide (FeO), ferric oxide (Fe_2O_3), silica (SiO_2), alumina (Al_2O_3), clay, carbonaceous matter, mica, talc, and minerals of the pyroxene group. The colors and stains commonly noted in limestones are due to the presence of foreign minerals. The light-blue, buff, yellow, pink, red, and brown shades are largely due to iron com-

[1] Clarke, F. W., The data of geochemistry: U. S. Geol. Survey Bull. 491, p. 531, 1911.

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pounds, and the grays and blacks are often due to the presence of carbonaceous matter derived from organic remains. Manganese oxides also act as coloring agents.

VARIETIES OF LIMESTONE.

An outline of the important varieties of limestone, based on texture is given below, but it must be borne in mind that a limestone may represent a mixture of several of the following varieties:

(1) Compact, dense, fine-grained limestone.
(2) Crystalline limestone (nonmetamorphosed).
(3) Crystalline limestone, or marble (metamorphosed).
(4) Oolitic and pisolitic limestone.
(5) Fossiliferous limestone.
(6) Shell limestone (fragmental, including coral limestone).
(7) Chalky limestone.
(8) Conglomeratic limestone.
(9) Cherty limestone.
(10) Fresh-water marl.
(11) Travertine, or calc sinter.
(12) Stalactitic and stalagmitic limestone and onyx marble.

Based on chemical composition, the following varieties may be distinguished:

(1) High-calcium limestone.
(2) Magnesian limestone.
(3) Dolomite.
(4) Argillaceous limestone.
(5) Arenaceous and siliceous limestone.

It should be emphasized that many of these varieties grade into one another, and that many limestones combine the characteristics of two or more varieties.

VARIETIES BASED ON TEXTURE.

Dense, fine-grained limestone.—The more compact, dense, fine-grained limestones are considered to have been deposited in quiet water, some distance from the shore, where only the fine-grained sediments would be carried by currents. However, it is possible that in many places this variety of limestone has been the result of chemical precipitation in shallow water. The lithographic limestone of Bavaria is dense and fine grained, and many of the beds in the so-called "Trenton" of the Mississippi basin are of this texture. Dense, fine-grained limestone where chemically of suitable composition is burned to lime in many places.

Nonmetamorphosed crystalline limestone.—The crystalline nonmetamorphosed limestones are of sedimentary origin. Their crystalline texture is probably due to recrystallization through the agency of water. These rocks are not true marbles, but are often so styled in a commercial sense, particularly if they will take a good polish. Well-known examples of crystalline nonmetamorphosed limestones occur in the vicinity of Knoxville, Tenn., Carthage, Mo., and Batesville, Ark. Lime is made from this variety of limestone at all these places.

Metamorphosed crystalline limestone (marble).—Marble is a term applied commercially, rather loosely, to a granular crystalline lime-

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stone or dolomite, and even to other rocks that are susceptible of polish and possess attractive colors. Scientifically, marble is a granular crystalline limestone or dolomite in which recrystallization has resulted from the effects of heat and pressure, usually aided by the action of water. True marbles are therefore found in regions that have been subjected to metamorphic action, and they are associated with other metamorphic rocks, such as gneiss, schist, quartzite, and slate, and are usually situated near areas of igneous rocks, such as granite and diorite. In pure limestone and dolomite little chemical change takes place during metamorphism to marble, but the rock mass becomes more completely crystalline. Deposits of marble occur in the form of lenticular masses, interbedded with other metamorphosed rocks, and also as metamorphosed zones along the contact of a limestone with an igneous rock. If the original limestone contains silica and other impurities, certain silicate minerals may be developed in the marble. The calcite crystals in a thin section of marble are generally irregular in size, shape, and arrangement, and many of these crystals are twinned.

Marble is burned to lime in New England and in many of the Appalachian States.

Oolitic limestone.—Granular limestone, composed of small, rounded, concretionary grains cemented together to form a solid rock, is known as oolitic limestones. The grains resemble the roe of a fish, and are named oolites, from the Greek word for "egg." The oolites are considered to have been formed by the deposition from solution of successive concentric coats of calcium carbonate about preexisting nuclei. These nuclei may be particles of sand composed of silica, or calcium carbonate, or of any other foreign matter, and it has even been suggested that minute gas bubbles may form a center of growth. If the concretionary grains are coarse and approach the size of a pea, the rock is termed pisolitic. Among the best-known examples of oolitic limestones are the stones quarried at Bedford, Ind., at Bowling Green, Ky., and at Darlington, Ala. A white oolitic limestone has recently been quarried near Bromide, Okla. Oolitic limestone sand is now forming on the south shore of Great Salt Lake, Utah, and is reported to be used as a flux by the copper smelters at Garfield.

Oolitic limestone generally makes a high quality of lime, and its use for this purpose is extensive in the localities where it occurs.

Fossiliferous limestone.—Fossiliferous limestones are so termed from the presence of noticeable quantities of remains of organisms. The texture of the fossiliferous rock may correspond with that of any of the water-laid, nonmetamorphosed varieties herein described, although the dense, fine-grained beds are likely to contain fewer recognizable fossils than some of the coarser varieties. The quantity of fossils present depends also on the period in which the beds were deposited. In the earlier sedimentary rocks, such as the Cambrian, fossils are much rarer than in those deposited later. The term "fossil" refers not only to perfect forms that have been embedded in the rock, such as the shells of sea animals, but to any fragment or form that has resulted from living organisms, whether animal or plant. The term "crinoidal" refers to a limestone that contains fragments of the stems of crinoids, or sea animals resembling lilies. Fossil impressions of recent leaves are also found in deposits of travertine.

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The mode of formation of the common types of fossiliferous limestone is very simple. When the animals that have extracted calcium carbonate from the water and incorporated it in their hard parts die, their shells and other secretions collect on the bottom of the sea. These materials, either whole or fragmentary, become cemented together principally by calcium carbonate, and the mass eventually forms limestone. Where sufficiently pure, fossiliferous limestone is generally suitable for making lime, particularly if it is slightly porous.

Shell limestone.—Shell limestone is simply a form of fossiliferous limestone, in which the mass of the rock is made up almost wholly of shells, of shell fragments, and of shell sand, more or less compactly massed together. The coquina at St. Augustine, Fla., is an example of this sort of rock, and coral limestone is of a similar nature, except that it is made up of fragments of corals. This type of limestone, where not too siliceous, generally makes good lime.

Chalky limestone.—Chalky limestone, or "chalk," is soft, fine-grained, light colored, white limestone, composed largely of the minute calcareous shells of foraminifera. These shells are mostly of microscopic size. Fine crystals of calcite (pure calcium carbonate, $CaCO_3$) are also present in places. This rock probably originated in quiet seas, little effected by débris from the land. Deposits of chalk occur in the Southern and Great Plains States, such as Alabama, Mississippi, Louisiana, Texas, Kansas, Nebraska, the Dakotas, and Colorado. Some chalky limestones contain too much clayey impurities to make good lime, but the highly calcareous deposits are exploited by lime manufacturers in many places.

Conglomeratic limestone.—Conglomeratic limestone consists of fragments of broken limestone that have been rounded by wave action and cemented together by calcium carbonate into a mass of rock. Such rocks are comparatively rare, but beds of this nature have been observed in the Ozark region of northern Arkansas.

Cherty limestone.—Cherty limestones are those containing nodules and bands of chert or "flint." Chert is composed of silica (SiO_2), and the nodules or concretions have been segregated within the limestone, either from the immediately surrounding rock, or from without by the agency of water. The nodules are probably of secondary growth rather than original deposits. Unless the chert can be separated and removed from the limestone at very little expense, cherty limestone is generally not suitable for lime manufacture.

Marl.—Fresh-water marl is a fine-grained loose, earthy material containing a large proportion of calcium carbonate. It occurs in the basins of small fresh-water lakes and in marshes. The material has been brought to the lakes by spring or stream waters carrying calcium carbonate in solution, and has been extracted by the direct action of vegetable and animal organisms, or precipitated chemically. Bodies of fresh-water marl are common in the southern peninsula of Michigan, in northern Indiana, and in western New York. This type of rock, owing to its occurrence in a loose state and in water, is more suitable for the manufacture of Portland cement than of lime.

Travertine.—Travertine, or calc sinter, often called calcareous tufa, is a massive, porous to compact limestone, deposited by waters of springs or streams along their courses. It is found over the faces of limestone bluffs, also filling crevices in limestone, and around

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springs. Travertine deposits relatively are not extensive, and the material is little used for lime making, although there are instances of its use in connection with other limestone with which it is associated.

Stalactitic and stalagmitic limestone and onyx marble.—Stalactites are the pendant, icicle-shaped forms of calcium carbonate, deposited from dripping water in caverns in the earth. Stalagmites are the forms that rise from the floors of caves toward the stalactites above, and are formed by lime-bearing waters dripping upon the floors of caverns. The principle already mentioned, that the solvent power of water is increased by the presence of carbon dioxide, is involved in the formation of caves and their deposits. In passing through the fractures or joints of limestone strata, or in slowly percolating through the pores of the beds, water takes up lime carbonate in solution, thereby enlarging the open spaces and forming cavities in the rocks. When these lime-bearing waters reach an open cavity, the pressure sustained by the water becomes less, carbon dioxide is given up, and evaporation takes place to a certain extent. Both of these factors tend to precipitate the calcium carbonate carried by the water. The reaction involving the precipitation of the calcium carbonate is as follows:

$$\underset{\text{Calcium bicarbonate (in solution).}}{CaH_2(CO_3)_2} \rightarrow \underset{\text{Calcium carbonate.}}{CaCO_3} + \underset{\text{Carbon dioxide.}}{CO_2} + \underset{\text{Water.}}{H_2O}$$

Some of the calcium carbonate is therefore deposited on the roof of the cavern, and the drops that finally fall from the stalactite at the top deposit part of the remaining calcium carbonate and form the stalagmite on the floor below.

Onyx marble is a chemical deposit of calcium carbonate whose deposition depends on the same principle as that of stalactites and other cave deposits of calcium carbonate, but which is considered generally to have resulted from precipitation by deep-seated hot-spring waters. Merrill [1] considers it probable that such deposits took place on the bottom of shallow pools. Onyx marble is very finely crystalline, and is generally banded, in some places delicately, in others, brilliantly. In composition the material generally carries 90 to 96 per cent calcium carbonate, 2 to 7 per cent iron carbonate, and less than 1 per cent of manganese carbonate. The iron and manganese compounds on oxidation produce the bright bands and veins of color that are characteristic of onyx marble. Large deposits of this material are found in warm, arid countries, in the neighborhood of recent volcanic activity, such as in Arizona, southern California, and Lower California. This rock is generally of more value for ornamental purposes than for lime manufacture.

VARIETIES BASED ON COMPOSITION.

High-calcium limestone.—The distinguishing characteristic of this variety of limestone is its freedom from magnesium, as well as from ingredients regarded as impurities, such as silica, alumina, the oxides and sulphides of iron, alkalies, phosphates, and organic matter. High-calcium limestone carries from 93 to more than 99 per cent

[1] Merrill, G. P., Stones for building and decoration, 3d ed., p. 245, 1903.

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of calcium carbonate, and may embrace all the physical varieties of limestone except the cherty rock. So far as composition is concerned; high-calcium limestone makes the purest and the most active lime.

Magnesian limestone.—Magnesian limestone is limestone containing magnesium carbonate in any quantity up to 45.65 per cent. The majority of magnesian limestones carry either a small percentage or a high percentage of magnesium carbonate, although there are here and there deposits that are intermediate in composition. Magnesian limestone may embrace several varieties, texturally, and if physically suitable may be burned to lime, which will be a mixture of calcium oxide (CaO) and magnesium oxide (MgO).

Dolomite.—Dolomite is a mineral composed of the double carbonate of calcium and magnesium ($CaCO_3.MgCO_3$). It contains 54.35 per cent $CaCO_3$ and 45.65 per cent $MgCO_3$.[1] In practice, magnesian limestone containing 20 per cent or more of magnesium carbonate has generally been called dolomite, but it would be preferable if magnesian limestone could be distinguished as "low magnesian" and "high magnesian," restricting the term dolomite to rock containing nearly, if not quite, the theoretical quantity of magnesium carbonate necessary to combine with the calcium carbonate in the proportions given above, or in the ratio of 1:1.19. The mineral dolomite in places forms rock masses, in which the crystals of dolomite can be distinguished. In some rocks these crystals make up a large proportion of the beds, and, on weathering, the rock crumbles to a sand composed of dolomite crystals. Rock and sand of this character are common in southwest Wisconsin near the junction of Wisconsin and Mississippi rivers. The texture of magnesian limestone and so-called dolomite is commonly more or less rough on weathered surfaces. The Galena dolomite of the Ordovician system and the Niagara limestone of the Silurian system are well-known representatives of this type of rock in the Mississippi Valley, and the Knox dolomite and the Shenandoah limestone in the Appalachian valleys both contain much dolomite.

In the formation of magnesian limestone and dolomite, magnesium carbonate is believed to have replaced calcium carbonate, either while the beds were being deposited in the sea, or after the beds became part of the land surface. The degree of replacement is variable, and ranges from less than 1 per cent to 45.65 per cent, although most commonly found to be either low or high. Rock containing a higher percentage of magnesium carbonate than true dolomite may be termed "supermagnesian" limestone, and if the theoretical quantity of calcium carbonate should be replaced by magnesium carbonate, the rock would become magnesite. This process of replacement is known as dolomitization, and is accompanied by contraction or shrinkage of about 12.3 per cent of the volume of the original limestone.[2] This contraction is believed to produce porosity in the rock under conditions in which the pressure is not sufficiently great to close the pores of the rock. The properties of magnesian and dolomitic limes are of much interest and are discussed at length on pages 1581–1593.

[1] Dana, E. S., A text-book of mineralogy, p. 356, John Wiley & Sons, New York, 1900.
[2] Van Hise, C. R., A treatise on metamorphism: U. S. Geol. Survey Mon. 47, p. 806, 1904.

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Argillaceous limestone.—Argillaceous limestone contains a considerable proportion of clay material, consisting mainly of silicate of alumina. If this is present in certain proportions, mortar made from the lime burned from this stone has the property of setting under water, and is therefore known as hydraulic lime. Clay material was probably introduced into the limestone during its formation on the sea bottom. Not a great deal of hydraulic lime other than a comparatively small quantity of "natural cement" is made annually in the United States.

Arenaceous and siliceous limestone.—Arenaceous limestone is a rock containing fine silica sand deposited with calcareous sediments in the sea. Other varieties of limestone contain silica in the form of quartz that has been introduced by ground waters into the pores of the rock, and into cavities, forming geodes, vugs, and veins, and limestone may contain a siliceous cement.

In rare instances limestone may contain calcium silicate, in the form of wollastonite, produced by igneous metamorphism. Such material has been noted near Havre, Mont. All such varieties of limestone, as well as the cherty variety mentioned above, are therefore siliceous; and, as silica, where present to the extent of 4 per cent or more, is an undesirable impurity, arenaceous or siliceous limestones are rarely suitable for making lime.

GRADATIONS IN LIMESTONE.

In the foregoing definitions and sketches of the origin and characteristics of the common varieties of limestones, an attempt has been made to show why it can not be expected that all deposits of limestone should conform to a single standard of purity. It should be added here that although the criteria for differentiating the varieties of limestone are very definite, there are all gradations from one variety of rock to another, and also there are many combinations of the varieties mentioned. On account of the method of formation of beds of limestone in nearly horizontal deposits in successive layers on the sea bottom, the character of the rock will be subject to greater variation in a given distance perpendicular to the bedding planes than parallel to them. It is a matter of common experience among quarrymen that in order to secure stone of uniform composition they must follow the beds that are of the desirable composition rather than extend the quarry into beds stratigraphically much higher or lower (across the beds). Broadly, there are also differences in composition of limestones from place to place along the same bed, and these differences are found to be greater in a direction at right angles to the shore line of the ancient body of water in which the rock was deposited than in a direction parallel to that shore line. This is explained by the sorting action of currents and waves.

IMPURITIES IN LIMESTONE.

From the points that have been mentioned in the foregoing descriptions of limestones, this subject need only be summarized here. Among the common impurities in limestone are clay material, silica, alumina, iron oxide or iron rust, iron carbonate, iron pyrites and marcasite or iron disulphide, gypsum, alkalies, and carbonaceous material. Clay is introduced into the beds while they are being

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deposited on the sea bottom, and is most often found along the bedding planes, but it is also disseminated through the rock. Clay also results from the decomposition of impure limestone in the process of weathering at the surface, in joint cracks that have been enlarged by solution, and in solution channels and caves. Much surface clay is carried down into the cracks, crevices, and irregularities in the rock surface, and when quarries are operated on a large scale, it is difficult to separate this clay cheaply from the adjoining limestone. Silica is both an original and secondary impurity in limestone. In marble it is usually found combined with some other mineral, such as alumina, iron, calcium, and magnesium, and occurs, therefore, in the form of silicate minerals. In ordinary hard limestone, it occurs as nodules or masses of chert (flint), or else combined with alumina as clay matter. In soft limestone, such as marl and chalk, silica usually occurs as grains of sand that were introduced during the deposition of the limestone, but certain beds of Cretaceous chalk carry an abundance of chert nodules, notably the chalk deposits along the English channel, and to a less extent in Texas. Alumina is commonly present in combination with silica as silicate minerals or as clay matter. Iron compounds may have been disseminated with the original sediments, but they have also been brought in by percolating waters. Chemical action between the iron compounds and the calcium carbonate and other minerals has resulted in the replacement of particles of limestone by iron compounds. Sulphur is present in combination with iron as the disulphide, and in gypsum ($CaSO_4.2H_2O$), so that it is not free under ordinary conditions. The alkalies, soda and potash, are present in some limestones in small quantities, probably in the form of carbonates and in the clay impurities as silicates.

On the outcrop and next to a cover of residual clay, débris, and soil, limestones are generally weathered to varying depths, depending on the physical and chemical character of the stone. Impurities are noted in greater proportion in the weathered rock than in the unweathered, because the impurities are less soluble than the limestone. It is difficult in quarrying to avoid the minor impurities that occur within limestones, but where chert occurs, if it can not be picked out advantageously, it is best to select other beds, for it can not reasonably be expected to disappear as the bed is worked farther from the outcrop.

STRUCTURE OF ROCKS.

GENERAL CONSIDERATIONS.

Originally the sediments composing beds of limestone were deposited in a nearly horizontal position, or with a low initial dip corresponding to the slope of an ocean beach or of the floor of a depression in the ocean bottom. Throughout the Central States and the Great Plains the rocks lie for the most part as they were deposited, namely, nearly flat, and quarry operators here usually have very simple conditions with which to deal. In New England, in the Appalachian region, in the Rockies, and in other western mountainous regions, however, beds of rock seldom lie in normal positions, but are in highly inclined or vertical attitudes, and in many instances the strata are bent, curved, twisted, and broken within small areas.

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The flat-lying strata have been very little disturbed during the broad oscillations of the earth's crust coupled with the retreat of the oceans, by which they were brought into their present position. Certain structural effects, however, have been introduced in these rocks, such as dislocations, called joints and faults.

DISLOCATIONS.

Joint.—A joint is a crack or crevice cutting beds of rock nearly in a plane. A joint plane generally makes a high angle with the bedding planes. (See Pl. IX, *A*.) Joints usually occur in systems, the planes of each system being roughly parallel to one another. Where there are two systems, the joints of each system are usually nearly at right angles to one another. In many regions, especially where the rocks have been much disturbed, there are several systems of joints, intersecting at various angles. The spacing of joints is rather irregular, some being only a few inches apart and others 50 to 100 feet, or more, apart. Joints are often enlarged by solution, and the spaces may be open, or they may be filled with residual clay, with clay and gravel that have been washed down from the surface, or they may be lined or filled with mineral matter deposited from solution, perhaps in

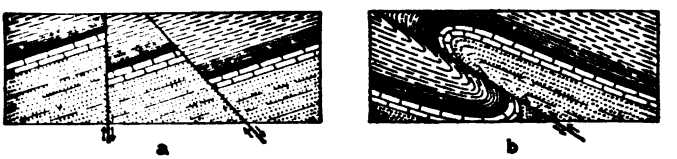

FIGURE 22.—Ideal sections of strata, showing (a) normal faults and (b) a thrust or reverse fault.

crystalline form. Advantage is often taken of the jointing of rocks in the operations of quarrying and mining.

Fault.—A fault is a fracture along which strata have moved unequally, so that the edges of strata on opposite sides of the fracture or fault plane do not correspond in position. There are many types of faults, but in flat-lying rocks the normal fault is the most common. The normal fault is one in which the fault plane is inclined toward the beds that have relatively slipped downward. The movements of the beds during faulting need not, however, have been mainly vertical. There are many places in which beds have been shoved over each other almost in a horizontal direction, and also in which the movement has been in a lateral direction along the fault plane. Of course, combinations of all these directions of movements are common. (See figs. 22 and 23.)

FOLDS.

The cooling of the earth's interior and the consequent shrinkage of the crust, and other causes, generate tangential forces that tend to produce corrugation or wrinkling of the crust. There are certain very broad types of corrugations of the crust, such as continents, ocean basins, and mountain ranges, but the type of most interest in the present connection is the minor one which includes rock folds or arches. Since stratified rocks were originally nearly horizontal, they were peculiarly subject to the crumpling action from the tangential

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A. JOINTED STRUCTURE IN HORIZONTALLY BEDDED NIAGARA LIMESTONE, DRUMMOND ISLAND, MICH.

B. OUTCROP OF CHICKAMAUGA LIMESTONE BEDS NEAR EWING, VA., SHOWING DIP AND STRIKE.

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pressure in the earth's crust, and they have very evidently suffered great disturbances in places. All inclined beds are portions of great rock folds or arches. Beds that slope downward into the ground do not continue to slope at the same angle, but at comparatively moderate depths the inclination gradually changes and the bed rises to the surface again. On the other hand, if the bed be projected into the air, it can be considered as bending downward

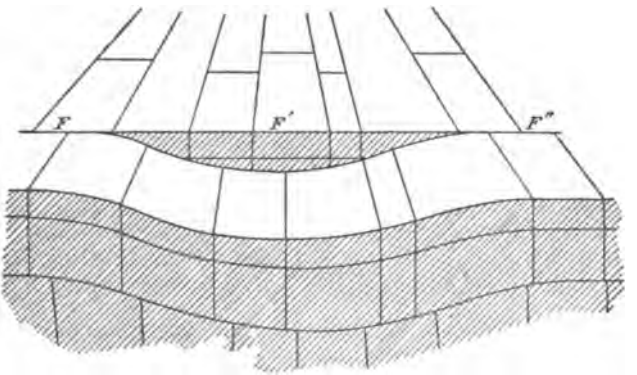

FIGURE 23.—Ideal diagram of a complete normal fault. (Modified from Crosby, W. O., Common minerals and rocks.) F–F'–F'', trace of fault plane on a flat surface.

again in an imaginary curve and descending to the level of the present surface at some point not far distant. The portions of beds that form the imaginary arch above the present surface have been removed by erosion, and generally there is little in the topography or surface relief to indicate troughs or arches in the strata. For his information, the geologist has to depend largely on sections afforded by stream cutting, artificial excavations, tunnels, etc., and on the

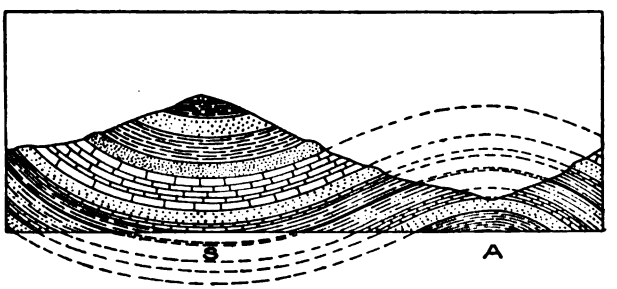

FIGURE 24.—Ideal section across folded strata. A, Anticline; S, syncline.

principles of the mechanics of geologic structure. A section across some folds of the character just outlined is given in figure 24.

Anticline, syncline, dip, and strike.—The troughlike arch or fold is termed a syncline and the upward bending arch an anticline. The median line passing lengthwise through the lowest points of a synclinal fold or through the highest points of an anticlinal fold is called the axis. The inclination of the beds to the horizon is their dip. The horizontal direction of the outcrop is called the strike. The

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strike is at right angles to the dip and is generally parallel to the axis of the fold. The dip involves two elements: (1) The direction of dip, which is always at right angles to the strike and is the direction of the steepest inclination on the surface of the strata; and (2) the degree of dip, which is the angle between a horizontal plane and the line of the steepest inclination. (See Pl. IX, *B*.)

Monocline.—In addition to the anticline and the syncline, there is a simple type of fold in which the beds bend from one nearly horizontal plane to another, and this type is known as a monocline.

General characteristics.—Rock folds are of all sizes, from minute wrinkles, such as are seen in hand specimens, to enormous arches several miles in length and width and many hundreds of feet in height or depth. The plan of a rock fold is a more or less elongated ellipse—that is, roughly boat shaped—and the axis of the fold may pitch at a low angle in one direction. Where the folding of a region has been intense the axial planes of the folds are generally inclined to the vertical, and the arch may even be pushed over to one side, so that the beds on the two sides, or limbs, of the fold dip in the same direction. Such a fold is said to be overturned. (See fig. 25.)

FIGURE 25.—Diagram showing unsymmetrical and overturned folds in marble strata at Lenox, Mass. (By T. N. Dale.)

This close folding in the case of brittle rocks, such as limestone, takes place very slowly at considerable depths below the surface and under great pressure, under conditions that may render the rock plastic. In many instances, however, fracturing and faulting of the beds have occurred as an accompaniment of close folding, and overthrust faults having a section similar to the type shown in figure 22, *b*, are developed in places. The best known examples in the United States of the folds outlined above are perhaps to be found in the southern Appalachian region.

Topographic expression.—On account of the modification of the earth's surface by erosion the various structural features of rocks are not always clearly shown in the topography. In areas of flat-lying rocks at considerable altitude above sea level, subject to stream erosion, the harder rocks stand out in bold cliffs, often protecting softer rocks beneath. Limestones form many stream bluffs and some ridges, but they are so soluble that more generally they form gentle slopes and valleys. Where rocks are thrown into folds the upturned edges of the harder beds on the limbs of the fold generally form the ridges, and the valleys are developed on the softer and more

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soluble rocks along the axes of the fold. In the majority of places ridges are developed near the axes of synclinal folds, and valleys are formed along the axes of anticlines (see fig. 24), but in some places the reverse relations occur.

AGES OF ROCKS.

TIME AND STRATIGRAPHIC SUBDIVISIONS.

The time during which rocks were formed is divided into major intervals called eras, which are in turn divided into smaller intervals called periods, and these into smaller subdivisions called epochs. The age of a rock is expressed by the name applied to the time interval in which it was formed.

All the sedimentary formations deposited during a period are together termed a system. The principal divisions of a system are called series. Any aggregate of formations less than a series is called a group.

FORMATIONS.

For purposes of geologic mapping rocks are divided into formations. A sedimentary formation contains between its upper and lower limits either rocks of uniform character or rocks more or less uniformly varied in character, as, for example, an alternation of shale and limestone. Where the passage from one kind of rocks to another is gradual, it may be necessary to separate two contiguous formations by an arbitrary line, and in some cases the distinction depends almost entirely on the contained fossils.

When for scientific or economic reasons it is desirable to recognize one or more specially developed parts of a varied formation, such parts are called members, or are designated by some other appropriate terms, such as lentils.

The names of formations or their subdivisions are derived from the localities in which the rock is most typically developed.

Value of fossils.—Sedimentary deposits accumulate successively; therefore the younger rest on those that are older, and their relative ages may generally be determined by observing their positions. In many regions of intense disturbance, however, the beds have been overturned by folding or superposed by faulting, so that it may be difficult to determine their relative ages from their present positions. Under such conditions fossils, if present, may indicate which of two or more formations is the oldest. Only the simpler kinds of marine life existed when the oldest fossiliferous rocks were deposited. From time to time more complex kinds developed, and as the simpler ones lived on in modified forms life became more varied. But during each period there lived peculiar forms which did not exist in earlier times and have not existed since; these are characteristic types, and they define the age of any bed of rock in which they are found. Other types passed on from period to period, and thus linked the systems together, forming a chain of life from the time of the oldest fossiliferous rocks to the present. Where two sedimentary formations are remote from each other and it is impossible to observe their relative positions, the characteristic fossil types found in them may determine which was deposited first. Fossil remains in the strata of different

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areas, regions, and even continents thus afford the most important means for combining local histories into a general earth history.

It is in many places difficult or impossible to determine the age of an igneous formation, but the relative age of such a formation can in general be ascertained by observing whether an associated sedimentary formation of known age is cut by the igneous mass or is deposited upon it. Similarly, the time at which metamorphic rocks were formed from the original masses may be shown by their relations to adjacent formations of known age; but the age of the original rocks which have become metamorphosed is not always possible of exact determination.

ROCK SYSTEMS.

The systems and series to which distinctive names have been applied are given in order, from youngest to oldest, in the following table:

Rock systems and main subdivisions.

Era of deposition.	Rock system.	Rock series.
Cenozoic	Quaternary	Recent.
		Pleistocene.
	Tertiary	Pliocene.
		Miocene.
		Oligocene.
		Eocene.
Mesozoic	Cretaceous	Upper Cretaceous.
		Lower Cretaceous.
	Jurassic	Upper Jurassic.
		Middle Jurassic.
		Lower Jurassic.
	Triassic	Upper Triassic.
		Middle Triassic.
		Lower Triassic.
Paleozoic	Carboniferous	Permian.
		Pennsylvanian.
		Mississippian.
	Devonian	Upper Devonian.
		Middle Devonian.
		Lower Devonian.
	Silurian	
	Ordovician	Upper Ordovician.
		Middle Ordovician.
		Lower Ordovician.
	Cambrian	Saratogan or Upper Cambrian.
		Acadian or Middle Cambrian.
		Waucoban or Lower Cambrian.
Proterozoic	Algonkian	
	Archean	

THICKNESS OF SEDIMENTARY ROCKS.

The thickness of sedimentary rocks is measured in a direction perpendicular to their bedding planes. The thickness of such rocks in the crust of the earth is very great in places. In one of the very early systems the thickness of the sedimentary beds has been estimated at more than 15,000 feet. Probably no single limestone formation is anywhere near this thickness, however. The Shenandoah limestone has been considered as reaching a thickness of about 6,000 feet in Pennsylvania and of about 5,000 feet in southern Virginia, and the Knox dolomite has been found to reach a thickness of about 4,000 feet in the southern Appalachians. The majority of limestone formations, however, rarely exceed a thickness of 500 feet, and many so-called units are less than 50 feet thick.

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OVERBURDEN.

The overburden that must be stripped from limestone deposits in connection with quarrying varies with the location, position, and condition of the deposits. It may consist of the following types of material:

(*a*) Beds of limestone not suitable for lime manufacture.

(*b*) Beds of different kinds of rock, such as shale or sandstone.

(*c*) Residual soil, material from the limestone, such as clay and rock débris.

(*d*) Alluvium, loess, and glacial drift.

The materials under (*d*) consist of unconsolidated sand, silt, clay, gravel, and bowlders deposited by the agencies of water, wind, and ice. The western and southern limit of the area formerly covered by the glaciers in the United States in general corresponds with Missouri and Ohio rivers, and a line southeastward from northwestern Pennsylvania to Long Island, N. Y. Within this boundary deposits of glacial drift from a few inches to 75 feet or more thick cover the surface except where the drift has been removed by erosion, and in certain limited driftless areas, the largest of which lies principally in southwest Wisconsin. South and west of the drift boundary for a few miles there are thin and scattered deposits of drift, and in many places beyond are sheets of loam and gravel that have been derived from the drift deposits and transported by heavy floods at the close of the glacial epoch.

AGE AND GENERAL DISTRIBUTION OF LIMESTONES SAMPLED.

The limestones quarried at the several plants visited by Mr. Emley during the field work of 1909 to 1911 range in age from pre-Cambrian to Mississippian or lower Carboniferous, all the main systems except the Devonian being represented. The oldest rock sampled was the pre-Cambrian Franklin limestone near Hamburg, N. J. This is a very coarsely crystalline marble that has been subjected to metamorphism. Its local distribution is shown on the maps of the United States Geological Survey Folio No. 161, of the Franklin Furnace, N. J., quadrangle, and it extends beyond this area a few miles to the southwest and northeastward into Orange County, N. Y.

Representatives of rocks that may be of either late Cambrian or early Ordovician age, or that extend from the late Cambrian into the early Ordovician, are the Rockland formation quarried near Rockland, Maine, the Stockbridge limestone at Cheshire, Mass., and East Canaan, Conn., the Shenandoah limestone at Cedar Hollow, York, and Thomasville, Pa., and the Shenandoah group at Riverton and Indian Rock, Va. The distribution of the most important areas of the Rockland formation is shown on the maps of the United States Geological Survey Folio No. 158, of the Rockland, Maine, quadrangle, although there are a few small areas of this rock a few miles northwest of the Rockland quadrangle. From Canada to southern Connecticut the Stockbridge limestone or its equivalent extends as a belt of marble and highly crystalline limestone. This is quarried at the marble centers near Rutland, Vt., Lee, and Ashley Falls, Mass., and at the lime manufacturing points, Cheshire, Mass., and East Canaan, Conn. The upper part of the series in which the Rutland and Cheshire quar-

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ries are working is characterized by high-calcium stone, but at lower horizons, as at Lee and East Canaan, the stone contains a high percentage of magnesia.

Limestones of late Cambrian and early Ordovician age are therefore rather widely distributed in the eastern United States. Their composition, however, varies from high calcium to high magnesium, as is shown by analyses accompanying the discussion of lime manufacture, page 1558. This fact illustrates that the chemical composition of rocks of equivalent age is not necessarily uniform. In Pennsylvania and in Virginia the important formation or group of formations of late Cambrian and early Ordovician age is known as the Shenandoah limestone or Shenandoah group. These limestones find topographic expression in broad valleys, the Valley of Virginia being a notable example. The typical development of these limestones is in the Shenandoah Valley, whence the name. In Virginia the Shenandoah group of limestones includes some shale beds. At Indian Rock, Va., the stone quarried is in the Natural Bridge limestone, one of the formations of the Shenandoah group. Southward, in Tennessee and Alabama, limestones of Shenandoah age are included in the Knox dolomite. In portions of the Mississippi Valley, Minnesota, Wisconsin, Missouri, and Arkansas, late Cambrian and early Ordovician rocks occur and include beds of magnesian limestone and dolomite.

The next later series of rocks that yield great quantities of limestone for the manufacture of lime and cement is also of Ordovician age. From New England southwestward through eastern New York and the Appalachian valleys of Virginia and Tennessee into Georgia and Alabama these later Ordovician rocks outcrop generally parallel to those of late Cambrian and early Ordovician age. They also outcrop in the vicinity of Cincinnati, Ohio, central Kentucky, Nashville, Tenn., and in important areas of the Mississippi Valley in southeastern Minnesota, southwestern Wisconsin, northeastern Iowa, northwestern Illinois, and southeastern Missouri. Ordovician rocks are also well developed in the Ozark region outcropping along White River and its tributaries. The well-known term Trenton limestone has been applied to one of the most characteristic formations of the Ordovician system.

The rock sampled by Mr. Emley at the quarries of the Tennessee Marble Lime Co., at Knoxville, is the Holston marble, a lentil in the Chickamauga limestone, of Ordovician age. Among the other quarries at which limestones of Ordovician age were sampled during the lime investigation are those at Bellefonte, Pa., La Garde, Ala., and Glencoe, Mo.

The Silurian system contains many important areas of limestone and dolomite in central New York and in the Appalachian region of Pennsylvania, Maryland, Virginia, Tennessee, Georgia, and Alabama; also around the Cincinnati and Nashville uplifts; in the vicinity of the Great Lakes in Ohio, Indiana, Illinois, Michigan, and Wisconsin; in the Mississippi Valley in Iowa, Wisconsin, and Illinois; and in the Ozark region of Missouri and Arkansas. Quarries in the Silurian limestone that were sampled by Mr. Emley are those at Woodville, Ohio, Sheboygan and Highcliffe, Wis., and Manistique, Mich.

Limestones belonging to the Devonian system are generally of a high degree of purity. Rocks of this system are represented in

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Maine, New York, Ohio, Michigan, Indiana, Iowa, Missouri, Tennessee, and Arkansas, besides in the Appalachian region from Pennsylvania to Tennessee. In the southern Appalachians, however, the Devonian deposits are very thin and do not carry important beds of limestone. No quarry in Devonian rocks was sampled by the Survey during the field work on which this report is based.

The Carboniferous system, especially, in its lowest division, the Mississippian series, contains some thick and extensively distributed limestone formations. This series is typically represented along the inner Mississippi Valley in Illinois and Missouri. Mississippian rocks are well represented in other States of the Mississippi basin, large areas outcropping in western Pennsylvania, West Virginia, Ohio, Kentucky, Tennessee, northern Alabama, Indiana, Michigan, Iowa, Missouri, Arkansas, and Oklahoma.

The quarries both at Marblehead, Ill., and Ash Grove, Mo., are in rocks of the Mississippian series of the Carboniferous system.

GENERAL DISTRIBUTION OF LIMESTONE IN THE UNITED STATES EAST OF THE ROCKY MOUNTAINS.

The general distribution of the limestone formations in the United States east of the Rocky Mountains is shown on the map, Plate VIII. On a map having so small a scale there are necessarily many small areas omitted, and many inaccuracies in the boundaries. The main purposes of the map are merely to show in a broad way the areas in which limestone forms the principal surface rock as contrasted with the nonlimestone areas, and to differentiate the areas of high-calcium limestone from those areas which may contain more or less magnesian stone. One striking fact brought out by this map is that the total area of limestone east of the Rocky Mountains is not so great as has popularly been supposed. The misleading statement that received widespread publication a few years ago to the effect that there is hardly a county in the United States that is not supplied with the raw materials for the manufacture of Portland cement seems clearly to be refuted by this map, particularly when it is considered that only the nonmagnesian limestone (such as is shown by the blue pattern) is suitable for Portland cement. As a result of rough planimeter measurements of the areas of both kinds of limestone and of the nonlimestone country east of the Rocky Mountains it appears that only about 15 per cent of the total area can be considered as bearing limestone, and this percentage includes both the high-calcium and magnesian varieties. The percentage of counties containing high-calcium and magnesian limestone probably would be slightly greater. Of course, in much of the limestone area the rock is not accessible for quarrying.

In the following pages is outlined the general distribution of the limestone areas perhaps a little more fully than is expressed by the map (Pl. VIII). The areas in the smaller Eastern States are discussed by groups of States, but west of the Mississippi the discussion is by States. The reader who desires greater detail in regard to high-calcium limestone suitable for making Portland cement is referred to earlier Survey publications,[1] particularly to Bulletin 522, which

[1] Burchard, E. F., The cement industry in 1910: U. S. Geol. Survey Mineral Resources, 1910, pp. 488–532, 1911. Eckel, E. C., Portland cement materials and industry in the United States, with contributions by E. F. Burchard and others: U. S. Geol. Survey Bull. 522, 1913. (May be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 65 cents, or consulted in the larger public libraries.)

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contains a number of State maps on a scale of about 40 miles to 1 inch, showing the distribution of limestone formations within those States.

The location of every limestone quarry and lime kiln in the United States east of Mississippi River was shown in a series of seven maps in the chapter on the stone industry in Mineral Resources for 1911, Part II, and the location of every such plant in the States between the Mississippi and the western boundary of Montana was shown in a series of six maps in the corresponding chapter and volume of Mineral Resources for 1912. The quarries and lime kilns in the remaining Western States and in the Pacific coast States are shown in three maps accompanying the chapter on the stone industry in Mineral Resources for 1913. The locations of these kilns have been plotted in connection with the preparation of a map showing the quarries of stone of all classes. The location of quarries of limestone operated independently of lime kilns as shown on these maps are also of interest in the present study, since they indicate in a general way the distribution of limestone formations that are available for quarrying, although they in no way indicate the type of stone quarried.

Chemical analyses of a large number of typical limestones and limes produced in various parts of the United States were published in the chapter on the production of lime in Mineral Resources for 1911, Part II. For a summary of the recent literature on lime, see the bibliography at the end of the chapter on the production of lime in 1913, published elsewhere in this volume of Mineral Resources.

NEW ENGLAND STATES.

Limestone, lime, and marble.—Practically all the limestone in the New England States is so highly crystalline as to be considered marble. The principal areas of calcareous rocks are near the coast of Maine, in Knox and Waldo counties, and in western Vermont, Massachusetts, and Connecticut. Lime is the principal product of the Knox County, Me., area, and it is made on a large scale also in Berkshire County, Mass., and in Litchfield and Fairfield counties, Conn. In Vermont also the marble is suitable for the manufacture of lime, although the production of lime in that State falls below that of the other States mentioned.

The marble of New England as reported here includes four types of stone. By far the most extensive deposits are of true marble, the distribution of which is outlined above. The true marbles of Vermont are too well known to need description here. They consist of calcite and dolomite marbles, comprise white rock and rock of such tints as cream, gray, bluish, and greenish, and are used for structural, decorative, ornamental, and statuary purposes.[1] The active quarries are located principally in Addison, Bennington, Orange, and Rutland counties. The three other types of stone commercially termed marble are quarried also in Vermont. One type is a dark-blue, dense, fine-grained fossiliferous limestone quarried on Isle La Motte, in Grand Isle County. This rock takes a high polish, becoming nearly black when polished, and is used much for interior decoration. Floor tiles are made from it, and the slabs are often sawed so that they dis-

[1] Dale, T. Nelson, The commercial marbles of western Vermont: U. S. Geol. Survey Bull. 521, 1912.

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play a section of a large coiled gastropod shell (*Maclurea magna*) on the surface of the tile. Another type of marble is a mottled red and white quartzose and argillaceous dolomite. It is quarried at Swanton, Franklin County, and is commercially known as "Champlain marble." Besides various shades of red this rock also displays olive-greenish tints. It is very hard, taking a high polish, and is used chiefly for flooring and interior work. Stairways are built of it in many public buildings. The fourth type of stone, commercially styled marble, is not a marble at all, since it is not a calcareous rock. It is the so-called "verde antique marble" quarried at Roxbury, Washington County, Vt., and is in reality a serpentine, and therefore need not be further considered. The extent of the marbles of Isle La Motte, Swanton, and Roxbury is slight compared to that of the true marbles of Vermont. The belt of the latter rocks extends southward through Massachusetts, where it is quarried at 10 or more places in Berkshire County, into Connecticut, where it is quarried at one place for marble. Southward through Connecticut the stone becomes much fractured and is of value chiefly for the manufacture of lime.

NEW YORK, NEW JERSEY, AND PENNSYLVANIA.

Limestone and lime.—New York and Pennsylvania are both especially rich in limestone beds. A belt of Silurian limestones extends eastward from Buffalo nearly across New York, and adjoining this belt on the south are Devonian formations, which also carry limestones. On account of the proximity of these limestone areas to several east-west railroads and of the exceptional purity of the stone, they are extensively quarried, especially for flux for blast furnaces at Buffalo. East of Lake Ontario, in addition to a lobe of Silurian limestone there is an area of Ordovician rock which contains limestone in the vicinity of Watertown. Along St. Lawrence River and the northern end of Lake Champlain, Cambrian and Lower Ordovician limestones occur, and quarries are operated in the vicinity of Ogdensburg and Plattsburg. Lime is burned in many of these localities in New York, but the lime industry is much more widely distributed in Pennsylvania than in New York. In Pennsylvania limestones of commercial value occur in the western half of the State in the Carboniferous areas, and chiefly in the Pennsylvanian ("Coal Measures") formations. From the middle of the State eastward the limestones are chiefly of late Cambrian, Ordovician, Silurian, and Devonian age, and the limestone areas are distributed in long, narrow strips, analogous to the outcrops of the "valley" limestones in the southern Appalachians. The dips of the beds in eastern Pennsylvania are steep as compared with those in the western half of the State.

Many of the limekilns in Pennsylvania, are small and are operated intermittently by the farmers to furnish lime for local fertilizers.

Much of the limestone of New York, especially in the western half of the State, is high in calcium carbonate; in Pennsylvania both high-calcium and high-magnesian stone occurs in abundance, the magnesian rock being especially well represented in the valleys of southeastern Pennsylvania. The "cement" rock and purer limestone beds of the Lehigh district in eastern Pennsylvania are quarried to some extent for crushed stone. Near Philadelphia the limestone

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has been subjected to intense folding and pressure, and in many places the beds have been recrystallized to marble, although they are utilized mostly for lime rather than for marble. In northwest New Jersey the beds utilized for crushed stone in the Lehigh district of Pennsylvania extend into Warren, Sussex, and Hunterdon counties, N. J. Much of this rock is highly magnesian.

The New Jersey stone area is limited to the northwestern and northern part of the State. This is explained by the fact that the deposits of the Coastal Plain, which underlie the remainder of the State, are composed mainly of but feebly consolidated materials, such as clay and sand.

Marble.—True marble is not widely distributed in either New York or Pennsylvania. In New York there are deposits in Westchester County of a white and gray, coarsely crystalline dolomite, and it is reported [1] that one of the belts of this stone reaches Manhattan Island, crossing Harlem River at Kings Bridge. There are also deposits in St. Lawrence County of a coarsely crystalline, light-gray magnesian marble; and in Dutchess County, near the Connecticut line, are quarries of coarse white dolomite marble. In Pennsylvania, as mentioned above, true marble occurs in the southeastern part of the State, and the most noteworthy belt of this material extends northeastward from the southern part of Lancaster County across Chester County, well into Montgomery County. There are a few marble quarries in these areas in both New York and Pennsylvania.

The prevailing colors of the stone throughout the larger part of the southeastern Pennsylvania area are yellowish and bluish, clouded shades rendering the stone not especially desirable for building purposes, but not affecting its value for lime. In an area of highly metamorphosed rocks between Brandywine and Wissahicken creeks the stone is granular crystalline and is reported to contain white as well as veined marble.

In New York there are several localities in which the limestones outlined above are of pleasing colors and of such a texture that they will take a fine polish, and the products are commercially styled marbles. This type of marble is found in Clinton County near Plattsburg, in Essex County, and in Warren County at Glens Falls.

MARYLAND, DELAWARE, VIRGINIA, WEST VIRGINIA, NORTH CAROLINA, AND SOUTH CAROLINA.

Limestone, lime, and marble.—The limestones of this area fall physically into three groups: (1) The nonmetamorphosed limestones of the Appalachian valleys; (2) the metamorphosed or crystalline limestones of the Piedmont region, both of which are hard limestones; and (3) the soft limestone of the Coastal Plain. The great limestone deposits of the Valley of Virginia are the most noteworthy in this area. They are easily accessible and consequently are extensively utilized for lime burning. These same limestone belts extend from northern Virginia across the corner of Western Virginia and through Maryland into Pennsylvania. West of the Alleghenies there are hard limestone deposits in eastern West Virginia, but only in the northern part of the State are they extensively utilized for

[1] Merrill, G. P., Stones for building and decoration, p. 97, 1897.

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the production of stone and lime. Southwestward they extend into Tennessee. Limestone is not abundant in the Piedmont region, except where it has been altered to marble, but it is quarried in a few places, notably in Henderson, Transylvania, and Yadkin counties, N. C.; Cherokee County, S. C.; Loudoun County, Va.; and Frederick and Carroll counties, Md. The hard limestones may be either high-calcium or magnesian rocks. The soft limestones of the Coastal Plain consist largely of shell marl, and important quarries are situated in Norfolk County, Va.; Craven and Jones counties, N. C.; and Charleston County, S. C. The shell limestones are generally quite pure and contain little magnesia, but they contain considerable silica in places, owing to the admixture of sand.

The marble deposits are mainly east of the middle of the Appalachian area, either in the mountainous country or on the Piedmont Plateau. In some places crystalline limestone occurs among the rocks in the Great Valley which have suffered little or no metamorphism, and although some beds may not be true marbles, according to the strictest definition, they are, nevertheless, commercially to be regarded as marbles. The principal development of marble quarries in this area is in Baltimore, Carroll, Harford, and Washington counties, Md.; and there are also quarries in Albemarle and Botetourt counties, Va.; in Graham and Cherokee counties, N. C.; and in Oconee County. S. C.

Lime is manufactured extensively from these three tpyes of limestone, not only in the urban districts for industrial use but in the more sparsely settled areas for agricultural purposes.

TENNESSEE, MISSISSIPPI, ALABAMA, GEORGIA, AND FLORIDA.

Limestone and lime.—Calareous rocks predominate, at least so far as suitability for quarry purposes is concerned, in Tennessee, northern Alabama, and northern Georgia, and much of the limestone is suitable for the manufacture of lime. In Franklin County, Ala., are extensive quarries in an oolitic limestone that strongly resembles the famous Bedford (Ind.) limestone, and is of about the same geologic age. Much of the limestone quarried in these States is crushed for concrete, railroad ballast, wagon roads, and for fluxing iron ores. Some hard limestone occurs in Tishomingo County, Miss., but owing to the proximity of large quarries in Alabama it has not yet been utilized to an appreciable extent. In the deposits of the Coastal Plain there are soft limestones of Cretaceous and Tertiary age. In Choctaw, Clarke, and Washington counties, Ala., these rocks are utilized. Florida is largely underlain by beds of shell marl and chalky limestone of Tertiary and Recent age; but these limestones are covered, for the most part, by comparatively thick deposits of sand and gravel. The Coastal Plain material that is utilized in this State for limestone and lime is mainly in the vicinity of Ocala.

Marble.—The marble produced by this group of States is of two types. That of the Piedmont region in northwestern Georgia and east central Alabama is a true marble, much of which is beautifully white or white and veined. In Talladega County, Ala., in Cobb, Cherokee, Pickens, and Gilmer counties, Ga., and in other counties

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in this northeast-southwest belt are situated large deposits of this type of marble. The other type is a very important marble of commerce, the highly crystalline limestone in east and central Tennessee. This marble—the Holston marble lentil of the Chickamauga limestone—is particularly characteristic of the Appalachian Valley and is of Ordovician age. The marble, which may be regarded as a representative, is of several handsome shades, ranging from light-pink to a rich chocolate color. It has been subjected to some alteration through pressure. The beds are highly tilted and have been squeezed so as to distort the bedding planes and produce handsome veining effects called "crows' tracks or suture joints." Lime is produced in important quantities from the waste rock at certain of the marble quarries in the Knoxville district.

This type of marble occurs in Anderson, Blount, Coffee, Cumberland, Franklin, Hawkins, Knox, and Union counties, Tenn.

WISCONSIN AND MICHIGAN.

Limestone.—A considerable portion of the area of Wisconsin and Michigan is thickly covered by glacial deposits of clay, gravel, and sand. Doubtless this cover retards the development of quarries to some extent, first by obscuring outcrops of good limestone, and, second, by the expense which its removal entails in quarry operations. Silurian rocks underlie the greater part of the eastern tier of counties in Wisconsin, and contain a thick formation of magnesian limestone. This rock is quarried in many places for stone to be burned into lime, and also to be crushed for concrete, macadam, and railroad ballast. The proximity of some of the quarries in eastern Wisconsin to water transportation on Lake Michigan has greatly aided their rapid development. Bordering the Silurian rocks on the west and extending across the southern tier of counties is a belt of rocks of Middle and Upper Ordovician age, which also contain magnesian limestone. The limestone quarries west of Green Bay and west and south of Lake Winnebago, as well as in the southern counties, are in these rocks. Between the border of the Middle Ordovician area and the crystalline area of north-central Wisconsin is a wide belt of rocks of late Cambrian and early Ordovician age, consisting chiefly of alternating beds of sandstone and magnesian limestone. There are a few limestone quarries in these rocks, mainly near Mississippi River between Prairie du Chien and Hudson. The greater part of the lime made in Wisconsin is burned from Silurian magnesian limestone in the eastern part of the State, but there are a few small kilns burning lime for local use in the southern and western areas. One thin formation of relatively high calcium Ordovician limestone is burned for lime in Lafayette County.

In Michigan Devonian formations, largely of limestone, border the northern part of the southern peninsula of the State along Lakes Michigan and Huron, and also cross the southeastern part of the State from Lake St. Clair to the Ohio line. A small area of Silurian limestone borders Lake Erie in the extreme southeast corner of the State, and at the extreme northern point of the southern peninsula there is also a narrow strip of Silurian rocks. Bordering the north end of Lake Michigan and the Straits of Mackinac are Silurian for-

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mations that constitute the country rock for some distance back from the shore in the northern peninsula. This is an extension of the belt of rocks that borders Lake Michigan in eastern Wisconsin. Adjoining the Silurian area on the west and north are rocks of Middle and Upper Ordovician age that enter the State from west of Green Bay, Wis., and succeeding these rocks toward the west and north are formations of late Cambrian and Ordovician age that form the shore line of Lake Superior east of Marquette and part of the shore line between Marquette and Keweenaw Point, but which contain little limestone of importance. The central area of the southern peninsula of Michigan is underlain by rocks of Carboniferous age, largely sandstone and shale. The limestone quarries in Michigan are therefore distributed mainly around the borders of the southern peninsula and near the shores of Green Bay and Lake Michigan in the northern peninsula, and are mainly in rocks of Ordovician, Silurian, and Devonian age. There are certain exceptions, however, such as the quarries near Saginaw Bay, which are in Mississippian limestone. The limestones of the Carboniferous and of the Devonian are generally high-calcium rocks; the lower limestones are generally high in magnesium.

ILLINOIS, INDIANA, OHIO, AND KENTUCKY.

Limestone.—The central part of Illinois is so heavily drift laden that quarries can not generally be opened economically, and this condition applies also to much of the area of northern and central Indiana and to parts of Ohio.

In this group of States the principal limestone formations are of Ordovician, Silurian, Devonian, and Carboniferous age. Of the Carboniferous rocks the lowest or Mississippian series contains the most important limestone formations in the western part of the area. In Illinois the Ordovician formations in the north-central part, the Silurian in the Chicago area, and the Silurian and Devonian in the northwestern part of the State are all worked for limestone. Some high-calcium limestone is found in the Ordovician, but the beds are mainly magnesian. The Silurian limestones are also magnesian, but the Devonian limestone carries a high percentage of calcium carbonate. Along Mississippi River and the lower Illinois Valley practically all the limestone quarries are in Mississippian rocks, which are generally well exposed in the bluffs, and consequently economical quarrying sites are not difficult to find. Thus far development has taken place principally at points where railroads happen to be built near good limestone outcrops, although, of course, some quarries have been opened at a distance and connected with the main line by spur tracks. On Ohio River in southern Illinois Mississippian rocks are also quarried. In eastern Illinois a few quarries have been opened in Pennsylvanian rock, notably a large quarry producing limestone for blast furnace flux and Portland cement in Vermilion County. The Carboniferous rocks generally are fairly high in calcium and low in magnesium, but the Mississippian rocks particularly are apt to contain a considerable percentage of silica, in some places in the form of chert. Lime is made from all these limestones in Illinois.

Indiana is underlain by formations having the same range in age as those in Illinois. The Pennsylvanian rocks outcrop in western

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Indiana; Mississippian rocks are found in a belt a little west of the middle of the State and in an area in the extreme northeast corner; Devonian and Silurian formations underlie the northwestern, central, and northeastern portions, with Ordovician rocks in the southeast corner, which is affected by the Cincinnati anticline. The limestone quarries in Indiana are chiefly in the Mississippian, Devonian, and Silurian formations. Thirty-eight counties are reported as producers of limestone. Lawrence and Monroe counties are the principal producers of building stone in the State. The famous oolitic limestone quarried about Bedford as a center occurs in these counties in a favorable situation for quarrying. This limestone is of Mississippian age and has few counterparts in the United States so far as its physical characteristics are concerned. This Bedford stone is of medium fine-grained even texture, and is composed of small round concretionary grains and of broken fragments of fossils, all compactly cemented together by calcite. The stone occurs in masses 30 to 50 feet and even 70 feet thick. When fresh from the quarry the stone is soft and cuts easily, but after the "quarry water" has left the stone it becomes much harder. The color of the stone is a very attractive light gray, but it is easily affected by sulphurous and carbonic-acid gases and darkens quickly in the presence of soot. The instability of color is due largely to the high absorptive capacity and to the chemical activity of the stone, which is nearly pure calcium carbonate. On account of its evenness of grain and its softness when first quarried, the stone is easily dressed and carved and is very popular among builders for ornamental stone construction. The stone also possesses ample crushing strength for any use to which it may be put. A great industry has been built up in the district in which it is quarried in cutting stone according to specifications, and much special machinery has been designed for this purpose. On account of the purity of the stone, much of the waste from the quarries is used for making lime and for blast-furnace flux, and a Portland cement mill was operated for several years using this stone in the manufacture of a high-grade product. Some of the most easily accessible stone has now been worked out, and in places, in addition to 5 feet of clay, thicknesses of as much as 35 feet of less desirable overyling limestone have to be removed in order to reach the quarry stone.

In addition to the counties mentioned, Owen, Crawford, Harrison, and Washington counties, Ind., are said to be underlain by this oolitic limestone. In Bartholomew, Decatur, Jennings, and Ripley counties there is considerable quarrying in limestone of Devonian and Silurian age, and farther north, in Delaware, Grant, Wabash, and Huntington counties there are many quarries. This latter area is mainly in magnesian limestone of Silurian age. Some lime is burned from the Silurian limestone in Indiana, but the greater part of the output comes from the high-calcium Mississippian oolitic rock.

In Ohio the limestone quarries are chiefly in three areas which correspond to three geologic systems of rocks. In the northwestern and western part of the State the quarries are very largely in Silurian magnesian limestone; in southwestern Ohio near Cincinnati rocks of Ordovician age yield limestone low in magnesia but rather high in silica, or in silica and alumina; in eastern Ohio, in Carroll, Stark, Tuscarawas, and other counties, Pennsylvanian limestones are quarried. These latter rocks are high in calcium carbonate. Lime

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is burned principally from the magnesian Silurian limestone and from the high-calcium Pennsylvanian beds.

Kentucky is underlain by the same geologic formations that have been mentioned above in Illinois, Indiana, and Ohio. In fact, these four States are more closely associated geologically than any other group of the United States having an equal area. Kentucky has a less area, however, of Silurian rocks, these formations being confined to a narrow strip in central Kentucky around the border of Ordovician rocks that form the Cincinnati anticline. The formations that yield the greater part of the limestone quarried in Kentucky are of Ordovician and Mississippian age. The Ordovician system is represented in the central part of the State southward from Cincinnati, Ohio, and quarries in it are operated in Harrison, Bourbon, Scott, Franklin, Anderson, Fayette, Jessamine, Mercer, Boyle, and other counties. A small quantity of lime is burned in this area. Limestone quarries in Mississippian rocks are scattered pretty well through the southern part of the State, but the most important area is near Bowling Green, Warren County. An oolitic limestone outcrops here, very similar in physical characteristics and of nearly equivalent age to the stone described above occurring in the Bedford (Ind.) district. This oolitic limestone is in a massive, homogeneous stratum 22 feet thick. It is quarried and dressed on a large scale, and its production represents a large and growing industry. Other areas of oolitic stone occur near Somerset, Pulaski County, and in Barren, Simpson, Logan, Meade, Hardin, Grayson, Caldwell, Todd, Christian, Wolfe, Powell, and Rockcastle counties and is quarried in a few of them. This oolitic stone has a high content of calcium carbonate and is burned for lime at Bowling Green and several other places.

Onyx marble.—True marble does not occur anywhere in this group of States. In the mountainous regions of eastern Kentucky there may be thin beds of limestone sufficiently crystalline in places to take a good polish, but none have been noted by the Survey. The so-called marble reported as quarried in Barren County, Ky., is a cave deposit of calcium carbonate known as onyx marble. These deposits occur in caves in limestones and are formed by deposition from solution in waters that have percolated through the surrounding limestones into the cave and through release of pressure, evaporation, etc., have deposited the mineral matter held in solution. The formation of sheets of onyx marble on the ceiling or walls of caves and on the walls of enlarged openings along joint planes is analogous to the deposition of calcium carbonate to form stalactites and stalagmites in caves.

Some very beautiful effects are produced by cutting and polishing pieces of onyx marble so as to bring out the banding or other figures, and the material is in demand for decorative and ornamental purposes. This material is reported to be present in the limestone regions of Indiana, Tennessee, and Alabama as well as in Kentucky and should be suitable so far as composition is concerned for the manufacture of high-calcium lime.

MINNESOTA.

Limestone.—The limestone areas are mainly in the southeastern part of Minnesota along Mississippi River and westward to the middle of the southern part of the State.

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A considerable portion of Minnesota is thickly covered by glacial deposits of clay, gravel, and sand. Probably this cover retards the development of quarries to some extent, first, by obscuring outcrops of good rock, and, second, by the expense which its removal entails in quarry operations. The majority of the stone quarries are, therefore, near the streams, where erosion has cut sections through the glacial drift and exposed the hard rock, generally in terraces or bluffs.

Much of the limestone quarried along Mississippi River and its tributaries in Houston, Winona, Wabasha, Goodhue, and Washington counties is of Cambrian and Lower Ordovician age. The beds are generally highly magnesian and received the name "Magnesian" limestones in early geological reports. They are blue when freshly mined, but weather to a buff color. They lie horizontal and in beds from a few inches to a foot or two in thickness. This belt of rock extends up Mississippi River nearly to St. Cloud and up Minnesota River to beyond Mankato; it is quarried extensively near Kasota and Mankato both for building stone and for natural cement and at other places for crushed stone and for the manufacture of lime. Along Mississippi River the limestone is used extensively for riprap.

The quarries at Kasota and Mankato are in a high-grade magnesian limestone that can be tool-faced, carved, polished, etc. Although the stone at both places belongs to the same formation, that at Kasota is more worked for cut stone. The stone at Mankato is of a buff color, and that at Kasota is of a light-pink shade, banded faintly in places. The stone at Mankato is used largely for massive masonry and as crushed stone, whereas that at Kasota is used for flagging and for building purposes, including polished wainscoting and other interior work. The stone is a fine-grained, hard, highly magnesian limestone. At Kasota the beds range from a few inches thick at the top (the thinness is due to weathering) to about 4 feet below. Massive blocks 12 feet long may be quarried if desired. The stone is quarried to a depth of about 12 feet below the stripping, which amounts to 3 to 5 feet of sand and gravel. In winter the quarries are closed and the beds covered with straw so as to prevent the stone from being disintegrated by frost. The quarry companies have cutting shops at Kasota, at which the stone is sawed, tooled, turned and polished. The supply of stone here is ample and the facilities for its production are larger than the demand.

The United States post-office building at Aberdeen, S. Dak., is faced with cut stone from Kasota, and much of the "marble" wainscoting in the Minnesota State capitol building at St. Paul is of polished stone from Kasota.

Tests made by Maj. Q. A. Gillmore before 1875 showed this stone to have a crushing strength of 10,700 pounds per square inch on "bed"; specific gravity, 2.63; weight per cubic foot 164.4 pounds; and ratio of absorption 1.56.

Overlying the Cambrian and Lower Ordovician rocks in southeastern Minnesota, between Mississippi and St. Peter rivers, are rocks of Middle and Upper Ordovician age, including the so-called "Trenton" limestone. Quarries have been opened in these beds near Rochester, Mantorville, Faribault, and Minneapolis. The color and bedding of these rocks are similar to those of the earlier Ordovician rocks. Near Faribault certain of the limestone beds consist of so

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nearly pure calcium carbonate that the stone has been burned for the manufacture of lime for use in beet sugar refining. Most of the material for structural purposes produced from the so-called "Trenton" limestone is used in the form of rubble and crushed rock.

The local surface rock at Minneapolis is the so-called "Trenton" limestone. This rock consists of beds of high-calcium, fine-grained, dense, light-gray rock, beds of bluish to greenish argillaceous magnesian limestone, and beds that approach shale in texture. The first-mentioned beds are the most desirable for all purposes, but most of the quarries are obliged to move considerable of the inferior stone, and more or less of it is worked into the product.

Lime is burned from local stone in the following Minnesota counties: Blue Earth, Fillmore, Goodhue, Mower, Rice, and Scott. As noted above, the limestone in most of these counties is magnesian, but that in Rice and Mower counties is high in calcium carbonate. Analyses of certain of these limestones and limes are given in Mineral Resources for 1911, Part II, pages 673 and 701. The magnesian stone is of Ordovician age, earlier than the "Trenton," and the high-calcium stone belongs to the so-called "Trenton" and later formations. The quarry at Le Roy, Mower County, is in an area of Devonian rock.

Limestone is quarried in 16 counties in Minnesota, 6 of which produce lime; and in addition lime is burned near Duluth from stone quarried in Ohio and shipped by boat through the Lakes. As at present developed there are more quarries of limestone in Minnesota than of any other rock, and if the value of the output of lime, as well as of limestone is considered, the industry based on limestone quarrying yields more wealth than any other phase of the quarrying industry.

NORTH DAKOTA.

The stone resources of North Dakota have been little developed and there are very few data at hand concerning the undeveloped resources of the State. About two-thirds of the area of the State, viz, the portion north and east of Missouri River, is generally deeply covered by glacial drift, and rock exposures are scarce. Except in the valley of Red River, where there may be granite, the rocks below the drift are sedimentary beds of Cretaceous and Tertiary age which consist mostly of soft sandstone, chalky limestone, shale, and clay, thus affording but little suitable rock for quarrying. No lime production has been reported from North Dakota in recent years.

SOUTH DAKOTA.

The greater part of the area of South Dakota is underlain by sandstone, shale, clay, and chalky limestone of Cretaceous and Tertiary age. Glacial drift overlies much of the area of the State east of Missouri River. Aside from the Cretaceous and Tertiary areas there is one small but important area in South Dakota where hard limestones are available for quarrying, viz, the Black Hills uplift. Marble also occurs, but is not quarried at present.

Limestone and lime.—Except for beds of chalky limestone in the Cretaceous of eastern South Dakota (which are of value for cement making rather than for structural purposes), the limestone

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beds of importance occur in the Black Hills. The limestone beds in the Black Hills are mostly of Carboniferous age, but there are also Silurian, Triassic, and Cretaceous limestones in this locality. One of the most important limestones is the Pahasapa, of early Carboniferous (Mississippian) age. It is reported to be about 500 feet thick in the northwestern part and about 225 feet in the southeastern part of the Hills. The lower part is massive, and above there are cherty beds. This stone has been used mainly for smelter flux and for making lime. It has been quarried near Doyle, Pringle, and Deadwood. The Minnekahta limestone, of late Carboniferous (Permian) age, has been used for lime burning and for building stone. It averages less than 50 feet thick. It has been quarried at Spearfish. One limestone quarry is located in Cretaceous rocks at Chester, Lake County. Limestone, including that quarried for lime and flux, is obtained in five counties in South Dakota.

Marble.—According to Todd,[1] an extensive deposit of white, crystalline dolomite marble occurs 4 or 5 miles northeast of Custer. It grades from a pure white fine-grained crystalline rock to coarse mottled stone with thinner layers of white, attractively spotted and banded with light and dark green serpentine. The marble is in distinct layers from 1 to 3 feet or more thick, the upper layers being the thinner. The total thickness is 30 to 40 feet. The deposit is embedded in and interstratified with pre-Cambrian schists. The deposit has been prospected by means of strip pits at several points in a distance of 1½ miles.

A deposit of grayish schistose marble, 20 feet thick, occurs on Box Elder Creek, but no development is reported.

IOWA.

Limestone.—Although a considerable part of the surface of Iowa is covered with glacial drift, streams have so dissected the drift mantle as to produce many good exposures of the underlying beds of hard rock. Paleozoic rocks underlie the eastern two-thirds, as well as the southwest corner of the State. Cretaceous rocks underlie the remaining northwestern portion, with the exception of a few square miles in the northwest corner, which are underlain by Huronian (Sioux) quartzite. The Paleozoic rocks, which begin with the Cambrian and Lower Ordovician along Mississippi River in the northeast corner of the State, outcrop in successive northwest-southeast belts and include rocks of Middle and Upper Ordovician, Silurian, Devonian, and Carboniferous age. The Carboniferous rocks include large areas of Mississippian and Pennsylvanian rocks, and a very small area of probably Permian beds in Webster County. The Cambrian and Ordovician systems comprise beds of magnesian limestone, soft, friable sandstone, and some fairly high-calcium limestone; the Silurian and Devonian systems carry magnesian limestone and high-calcium limestone, respectively; the Mississippian series is composed mostly of high-calcium limestone, but some magnesian and some cherty beds and some sandstone; and the Pennsylvanian series contains much sandstone and a smaller pro-

[1] Todd, J. E., Mineral resources of South Dakota; South Dakota Geol. Survey Bull. 3, p. 88, 1902.

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portion of shaly limestone. Most of the systems contain shale, but no account is taken of that material in this connection.

The distribution of stone quarries follows closely that of the streams and incidentally that of the railroads, and also falls almost entirely within the area of Paleozoic rocks. With possibly the exception of limestone quarries in Montgomery County, apparently there are no regularly working quarries in the Cretaceous areas, although doubtless there are a few local pits that produce limited quantities of Cretaceous limestone for use on the farms.

The limestone quarries of Iowa are distributed over the eastern two-thirds of the State and have been opened in each of the Paleozoic limestones mentioned above. Probably the greater number of quarries are in limestone of Mississippian age, although there are numerous quarries in the Cambrian and Ordovician areas. There are about 243 limestone quarries in Iowa in 42 counties. Twenty-three of these quarries in 7 counties produce stone for making lime. High-calcium lime is burned from formations of Mississippian and Devonian age and magnesian lime is produced from Mississippian and Ordovician rocks.

NEBRASKA.

Limestone.—With three exceptions—quarries at Sidney, Cheyenne County, and at Scotia, Greeley County, in limestone of late Tertiary age, and quarries at Roca, Lancaster County, in Cretaceous beds—the limestone quarries in Nebraska are in rocks of Carboniferous age, and are confined to the southeastern portion of the State south of Omaha and east of Lincoln. Most of these quarries are in Pennsylvanian areas, but some are in the Permian. A fossiliferous limestone containing a great number of Fusulina, a fossil resembling a grain of wheat, is very common. The greater part of the output of limestone in Nebraska is sold as crushed stone mostly for concrete, and the next largest item, comprising nearly 10 per cent of the total value, is the production of riprap on Missouri River.

Lime production is reported from only one locality, Weeping Water, Cass County. The total number of limestone quarries is 32, distributed among 9 counties in Nebraska.

There is little literature available on the quarrying industry in Nebraska, but fortunately a report has been published on the geology of Cass County,[1] one of the most important stone-producing counties in the State, and also a report on a special phase of the industry, viz, the production of flint ballast.[2]

Woodruff states that the stone-producing area is in three localities, one along the Platte, another on the Weeping Water, and between these two a small triangular section facing Missouri River. The overburden is generally loess, ranging in thickness from a few feet to 20 or more feet. The State capitol at Lincoln is built of native Carboniferous limestone quarried at Louisville, Cass County.

In Gage County cherty limestone, apparently in the area of Permian rocks, is crushed and screened at several quarries and marketed for railroad ballast and concrete. The markets for this material are by no means local but extend well beyond the borders of Nebraska.

[1] Woodruff, E. G., The geology of Cass County, Nebr.: Nebraska Geol. Survey, vol. 2, pt. 2, 1906.
[2] Barbour, E. H., The flint ballast industry of Gage County, Nebr.: Nebraska Geol. Survey, vol. 3, pt. 5, 1909.

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MISSOURI.[1]

The southeastern part of Missouri, comprising over one-fourth of the area of the State, is overlain by rocks of Cambrian and Ordovician age consisting chiefly of interstratified magnesian limestone and sandstone. Bordering the Ordovician rocks on the east, north, and west, is a belt of Mississippian rocks. These rocks form the inner valley and bluffs of Mississippi River except for part of its course north of the mouth of the Missouri in Pike and Lincoln counties, where Silurian rocks outcrop. The Mississippian rocks extend westward from the Mississippi north of the Missouri, crossing the Missouri in Boone County, and in Pettis County they make an abrupt bend to the south and southwest, extending beyond the southwest corner of the State into Arkansas and Oklahoma. They consist largely of limestone, some of which is cherty. A narrow belt of Devonian rocks lies between the Ordovician and the Mississippian areas north of Missouri River in Callaway, Montgomery, Warren, and St. Charles counties. The Devonian and Silurian rocks consist largely of limestone. North and west of the Mississippian area Pennsylvanian rocks occupy the remainder, or nearly one-half the area of the State. The Pennsylvanian rocks consist of sandstone, shale, and limestone.

Limestone.—The wide distribution of limestone in Missouri, which has already been outlined, insures a large production of this valuable material. Most of the limestone is suitable for crushed stone, and much of it is also suitable for building stone, for the manufacture of lime and for flux, so that each of these branches of the industry contributes largely to the output of limestone. Limestone of Cambrian and Lower Ordovician age is quarried in Missouri in the following counties: Bollinger, Cape Girardeau, Cole, Dallas, Franklin, Madison, Miller, Moniteau, Osage, Perry, St. Francois, and Wright; Middle and Upper Ordovician limestone in Cape Girardeau and Jefferson counties; Silurian limestone in Lincoln and Pike counties; Devonian (probably) limestone in Jefferson County; Mississippian limestone in Barry, Boone, Callaway, Clark, Cooper, Greene, Jasper, Jefferson, Knox, Lawernce, Lewis, McDonald, Marion, Monroe, Montgomery, Pettis, Pike, Platte, Ralls, St. Charles, St. Clair, St. Louis, Saline, and Shelby counties; and limestone of Pennsylvanian age in Andrew, Atchison, Audrain, Bates, Buchanan, Caldwell, Carroll, Cass, Clark, Clay, Clinton, Daviess, Dekalb, Grundy, Harrison, Holt, Jackson, Knox, Lafayette, Linn, Livingston, Mercer, Montgomery, Platte, Ray, St. Clair, Saline, and Sullivan counties.

A total of 283 quarries have produced limestone in the last two or three years, of which 80 quarries furnished stone for making lime. Out of the total of 283 quarries, 41 were in Cambrian and Lower Ordovician limestone, 8 in Middle or Upper Ordovician, 5 in Silurian, 4 in Devonian, 105 in Mississippian, and 120 in Pennsylvanian limestone. Of the quarries producing stone for lime 12 were in Cambrian and Lower Ordovician limestone, 5 in Middle or Upper Ordovician, 1 in Devonian, 59 in Mississippian, and 3 in Pennsylvanian limestone. It is thus evident that the Mississippian and

[1] A detailed report entitled "Lime and cement" was published by the Missouri Bureau of Geology and Mines as vol. 2, 2d ser., 1904.

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Pennsylvanian series contain the most extensively worked limestone formations, and that for the manufacture of lime the rock of Mississippian age has proved most suitable. The Mississippian limestone is mostly high-calcium stone; the beds of Cambrian and Lower Ordovician age are highly magnesian, and certain of the limestone beds of the Middle and Upper Ordovician are high in calcium carbonate. Analyses of many limestones from Missouri are given in Mineral Resources for 1911, Part II, pages 673–674.

A well-known representative of the Mississippian rocks is the limestone quarried at Carthage, Jasper County, at Phenix, Springfield, and Ash Grove, Green County, and near Hannibal, Marion County. The largest limestone-quarrying center in the State is at Carthage. Here the stone is of a remarkably uniform color, a faint bluish-gray in the quarry, and bluish white when cut and dressed. The rock is composed of medium-sized, irregular grains of calcite, closely interlocked, cemented by a calcite matrix. Analyses show more than 98.5 per cent of calcium carbonate and less than 0.25 per cent of iron oxide and alumina. The rock occurs in thick beds. Some chert is present near the base, but can easily be separated in quarrying This limestone shows stylolitic or suture jointing along the stratification planes, but these joints are generally so tight that the rock does not break readily along them. To avoid showing these stylolites on a sawed face the stone is generally sawed parallel to the bedding and laid on edge in the wall. Few limestones will admit of this practice, but in the case of the stone at Carthage the results appear to be satisfactory. The stone is considerably harder and consequently more difficult to saw and dress than limestones of the type quarried near Bedford, Ind., and it is also considerably stronger and denser and is less affected by the weather and by soot, gases, etc., than most other limestones.

The limestone quarried at Carthage is used principally for building purposes, either rock-faced, tooled, or hammered; some is polished for interior decoration; and a considerable quantity is burned for lime. Some producers term the rock a marble.

The limestone quarried at Phenix is more coarsely crystalline than that at Carthage. It has a bluish-gray color and uniform texture and occurs in thick beds. It is used for both building material and for lime manufacturing.

KANSAS.

Limestone.—Limestone beds belonging to four geologic divisions are abundant in Kansas. From the lowest up, these divisions are as follows: Mississippian series, Pennsylvanian series ("Coal Measures"), Permian series, and Cretaceous system.

Mississippian rocks occur only in one small area in the extreme southeast corner of Kansas, about 30 square miles in Cherokee County being covered by rocks of this age. This series is composed of limestone with interbedded chert and a few beds of shale. The limestone is usually heavy bedded and low in magnesia. It is said to be the rock that is extensively quarried at Carthage and other points in Missouri. Pennsylvanian rocks outcrop in the three eastern tiers of counties and in part of the counties in the fourth tier. Although made up mostly of shale and sandstone, the series includes many thin

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beds of limestone. Permian rocks occur west of the Pennsylvanian rocks and include a few beds of limestone. The chalk and chalky limestones of the Cretaceous occur in western Kansas. The principal outcrops are in Jewell, Smith, Phillips, Rooks, Osborne, Graham, Ellis, Trego, Grove, Logan, Ness, Lane, and Finney counties, and the same rocks are exposed in southern Nebraska and along Republican River.

A brief outline of the stone resources and industry of Kansas has been published by the University Geological Survey of Kansas,[1] from which the following quotation concerning limestone is taken:

Years ago * * * Mississippian stone was quarried at Galena, at Lowell, and elsewhere for the production of lime. It is so abundant in quantity and so easily accessible along the hillsides that it is a great wonder more limekilns are not in operation. The same rock is quarried at different places in Missouri and burnt into lime, producing lime of a good quality, but no better than might be obtained from Kansas quarries.

To the northwest of Cherokee County many local quarries in heavy limestone formations have been operated, some of which are still operated in an irregular manner. The most extensive of these is the quarry at Iola, which has produced large quantities of dimension stone and sawed flagstone for local trade and for shipment to other points. The limestone at Iola exists in a layer nearly 40 feet thick, from which dimension blocks of any size or proportion desirable can be obtained.

Still farther to the northwest the next quarries are those along the banks of the Kansas River west of Kansas City, from which large quantities of stone are taken for ballast and for macadamizing streets. Near Kansas City a deposit of fragmentary material exists from which large quantities have been shipped for making sidewalks and for macadamizing streets and for similar purposes.

Other places furnish quantities of stone, the output of which would be greatly increased if the demand were sufficient to justify the extensive operation of quarries. Generally, however, it is principally a local demand, for which no statistics can be gathered, but which in the aggregate amounts to many thousands of dollars.

Still farther west a limestone exists which is remarkable in many of its properties, permitting it to be successfully quarried for all kinds of dimension stone wherever it comes to the surface. It is known commercially as the Cottonwood Falls limestone, because such large quantities have been shipped from Cottonwood Falls and Strong City to so many points within and without the State. The same rock has been quarried at a dozen or more places to the north of Cottonwood Falls, such as Eskridge, Alma, Manhattan, Beattie, and a number of other places. This limestone is not very thick, averaging from 5 to 8 feet, and generally consists of two individual layers, known in the markets as the "upper" and the "lower." The rock from the two layers differs slightly in quality, the lower one generally producing the best stone. Its most valuable properties are two—almost perfect uniformity of texture throughout and the absence of vertical fissures. It is white or light cream in color, fine and noncrystalline in texture, and well filled with the little rice-grainlike invertebrate fossils, *Fusulina cylindrica*. The color is so uniform that when the stone is placed in a building the general color effect is very pleasing and satisfactory. The absence of vertical fissures and the uniformity of texture throughout make it possible to obtain dimension blocks of any size desired, which can be worked with perfect uniformity. * * *

A few hundred feet above the Cottonwood Falls limestone are heavy beds of the Permian limestone, which are unusually filled with flint nodules. These soft Permian limestones, carrying so much flint, are very serviceable for railroad ballast and are extensively quarried and crushed for this purpose at different places. The quarry near Strong City has probably yielded more ballast of this kind than any other one in the State, but extensive quarries are operated farther west along the Santa Fe at Florence and near Marion, and along the Rock Island at different points, all of which produce practically the same kind of stone.

In the central and west-central part of the State the Cretaceous limestones have been quarried to a great extent. On account of their soft, chalky character they are generally spoken of locally as a magnesian limestone, although such a term is entirely misapplied. A belt of country stretches across the State, by way of Beloit and Russell, throughout which a fine layer of limestone is quarried and broken into pieces suitable for fence posts. The Cretaceous limestones also serve many structural purposes in

[1] Haworth, Erasmus, Mineral resources of Kansas for 1897: Kansas Univ. Geol. Survey, pp. 74–76, 1898.

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all of the cities and villages within the Cretaceous area. The rock is so soft it can easily be sawed into blocks and worked with chisel and hammer much more rapidly than ordinary limestone. This, added to its property of materially hardening after being quarried, greatly increases its value. None of it is what would be called a first-class building material, yet it is capable of being used in many ways to a great extent, and furnishes a convenient and durable structural material for that part of the State, which tolerably effectually prevents other stone from being shipped in.

More than 200 quarries report recent production of limestone in Kansas, including 22 quarries which supply stone for lime burning. All but 6 of the localities, which are in the Cretaceous, are in the Paleozoic limestone. The total number of limestone-producing counties in Kansas at present is 41, in 7 of which lime is burned. The largest item among the limestone products is crushed stone, although building stone and stone for paving are produced also in large quantities.

ARKANSAS.

Limestone and marble.[1]—The Ozark region of northern Arkansas is underlain by several formations containing limestone, some of which are of great beauty and value. Certain of the limestone beds are composed of crystalline calcite and take a fine polish, and they are therefore commercially classed as marble beds, although they do not fulfill all the requirements of the scientific definition of marble. In this description the term "marble" will be used in its broad and popular sense. In the Ozark region hundreds of miles of outcrop of limestone and marble are afforded by the dendritic drainage of White River and its tributaries. The rocks lie nearly horizontal and are generally finely exposed in the stream bluffs. The principal limestone and marble formations are the following: Magnesian limestone of Cambrian and Lower Ordovician age, several beds including "cotton rock"; Izard limestone, a blue, dense, amorphous stone, about 280 feet thick, of Ordovician age; the St. Clair marble (Silurian), a fine-grained fossiliferous crystalline rock, about 150 feet thick, varying in color from light gray to dark chocolate brown, the St. Joe limestone member of the Boone limestone (Mississippian), a fine to medium grained crystalline fossiliferous limestone, showing in some places an abundance of crinoid stems and varying in color from light pink to dark chocolate brown, also mottled with gray and green, having generally a thickness of 25 to 40 feet, but in places reaching 100 feet; gray crystalline limestone of the Boone limestone (Mississippian) in places oolitic, as near Batesville; the Pitkin ("Archimedes") limestone, of Mississippian age; and the Brentwood ("Pentremital") limestone member of the Bloyd shale, of Pennsylvanian age. These limestones and marbles, with the exception of those of Cambrian and Lower Ordovician age, which are highly magnesian, are all high in calcium carbonate. Relatively the great limestone and marble resources of northern Arkansas have been little developed, partly because of the lack of transportation lines and partly on account of the lack of large markets. Two railroads have been recently built in a northwest-southeast direction across the Ozarks, connecting the Frisco and Kansas City Southern lines on the west with the Iron Mountain route on the east, and this has led to the opening of a

[1] See the exceptionally full and detailed report of T. C. Hopkins, entitled "Marbles and other limestone": Arkansas Geol. Survey Ann. Rept. 1890, vol. 4, 443 pp. and atlas, 1893.

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number of quarries near the new railroads. The limestone near Batesville is a grayish-white, hard, crystalline rock, and will take a good polish. It occurs in layers 3 to 5 feet thick, is comparatively free from seams or flaws, and it is reported that it can be quarried in as large pieces as can be handled. It makes an excellent building stone, and the new State capitol at Little Rock is being constructed from this material. The high degree of purity of many of the limestones of northern Arkansas renders them suitable for the manufacture of lime, and a thriving lime industry has been built up in this part of the State.

Twelve quarries in Arkansas have recently reported the production of limestone, besides 13 quarries which produced stone for lime, and 7 quarries have reported the production of marble. Thirteen counties comprise the area from which these three products are obtained. The principal uses for the limestone appear to be as crushed stone for concrete and as stone for building purposes.

LOUISIANA.

Limestone.—Practically the whole of Louisiana is within the Coastal Plain and is underlain by formations of Tertiary and Quaternary age, consisting principally of clay, sand, and soft limestone. Locally there are hard beds of limestone and sandstone in the Tertiary deposits, and if situated conveniently to transportation lines they may be quarried.

The only limestone reported as quarried in Louisiana is near Winnfield, Winn Parish. Hand specimens of this limestone sent to the Survey are of a dense, subcrystalline, bluish limestone, gashed and seamed with white calcite veins from the thickness of a knife blade up to three-fourths of an inch. The material makes a good crushed stone for ballast, macadam, and concrete. An analysis published in Mineral Resources for 1911 shows nearly 92 per cent calcium carbonate, and the material is probably suitable for the manufacture of lime.

OKLAHOMA.

Limestone.—Limestones of several different ages occur in Oklahoma. The earliest rocks are those of the Cambrian, Ordovician, and Silurian systems, which have a total thickness of nearly 8,000 feet, and make up a large part of the Arbuckle Mountains and the northern foothills of the Wichita Mountains. The lowest of these, the Arbuckle limestone, consists of limestone and dolomite of Cambrian and Ordovician age. It is 4,000 to 6,000 feet thick, and samples from the lower part and from the upper 600 or 700 feet which have been tested for magnesia and lime show a very small percentage of magnesia. Probably 2,000 feet of massive beds in the middle part of the formation are highly magnesian. The Viola limestone, of Ordovician age, 500 to 700 feet thick, outcrops in a belt about the border of the Arbuckle Mountains and in small areas in the central part. It also occurs in three small hills near Rainy Mountain Mission, in the Wichita Mountains. This formation contains local deposits of chert, but samples taken from the Arbuckle Mountain area show it to contain very little magnesia. It is fine textured and generally hard. Still higher lies the series of Silurian and Devonian limestones, which have been called "Hunton limestone," but which are now differentiated into several

formations. They have an average thickness of about 200 feet, and vary in physical character and composition. A massive bed at the base is in places almost pure white limestone; in other places it is in large part siliceous. Toward the middle, beds of clay and "marl" are interstratified with the limestone. Near the middle the beds contain a small amount of magnesia, and toward the top local segregations of chert are found. Like the Viola limestone these limestones outcrop around the borders of the Arbuckle Mountains in a narrow belt, besides occurring in many small areas in the central part of the uplift. In northern Oklahoma are a few belts of Carboniferous limestone, continuations of the areas which are so important in Kansas. These limestones thin out and disappear to the south and are of workable thickness only in the northern part of the State. Other thin-bedded limestones of Carboniferous age occur in eastern Oklahoma and extend into Arkansas north of the Boston Mountains. Along the southern edge of the coal field outcrops a long lentil of Mississippian limestone, the Wapanucka, which attains in places a thickness of nearly 300 feet. The eastern end of this belt extends nearly to the Arkansas line on the north flank of the Wichita Mountains and the western end reaches the Arbuckle Mountains. Gould [1] considers that the Wapanucka limestone is the most valuable limestone in the State for general utility. Near Bromide the stone is white and oolitic and makes an excellent building stone, the ledge being 50 to 70 feet thick. At Wapanucka and Hartshorne this stone is burned into lime; at Limestone Gap it is crushed for ballast and concrete; and at Hartshorne it is planned to use it as Portland cement material.

Cretaceous limestones occur in the southern part of the State, and several distinct formations are associated with limy clays. These limestones are mostly soft, thin bedded, and of various shades from light-blue to white. The lowest bed is massive, white, and generally homogeneous.

Gould [2] discusses the limestones of Oklahoma according to six separate areas: Northern Oklahoma, the Ozark uplift, the Wapanucka limestone area (in southeastern Oklahoma), the Cretaceous area (south of Wapanucka area), the Arbuckle Mountains area, and the Wichita Mountains area. In his discussions and in his maps Gould appears not to have included limestones that, according to reports to the United States Geological Survey from producers of stone and lime, outcrop in Major, Dewey, Blaine, northern Kiowa, Greer, and Jackson counties, and which are apparently in the area of Permian rocks.

Limestone has been quarried recently in 27 counties of Oklahoma from a total of 67 quarries, 10 of which quarries produced stone for lime.

Marble.—One deposit of true marble has been discovered in Oklahoma. It is exposed at several localities along Sallisaw Creek, in Sequoyah County. Its color ranges from pure white to pink and in places it is mottled. This deposit is near the Mississippian-Pennsylvanian geologic boundary, but is probably within the Mississippian area.

[1] Gould, C. N., and others, Preliminary report on the structural materials of Oklahoma: Oklahoma Geol. Survey Bull. 5, pp. 77–78, 1911.
[2] Idem, pp. 72–83.

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This marble has been quarried near Marble City, and most of the product used for building stone, some of it in the construction of buildings in Oklahoma City.

TEXAS.

Limestone.—The sedimentary rocks of Texas include representatives of most of the systems from the Cambrian to the Tertiary. Hard rocks of Paleozoic age extend well into north-central Texas. Tertiary rocks of the Great Plains underlie the western part of Texas as far south as Pecos River. On the Gulf Coast of Texas are sand and clay of Quaternary age, with three parallel belts of Tertiary rocks of different stages of deposition lying farther inland, while still farther in the interior, or extending in a northeast-southwest direction across central Texas and beyond Red River into southeastern Oklahoma, are two belts of Cretaceous rocks.

Limestone occurs in rocks of the Cambrian, Ordovician, Carboniferous, Cretaceous, and Tertiary systems. In particular, the Cretaceous of central Texas consists very largely of limestone. The principal area of Cretaceous rocks occurs as a wide belt extending southward across the central part of the State from Red River to the Rio Grande. The cities of Sherman, Dallas, Fort Worth, Waco, Austin,[1] and San Antonio are located on this belt. A railroad either follows or parallels this belt of Cretaceous rocks, and many railroads cross it. Two divisions of the Cretaceous system contain limestone deposits of remarkable purity. These are the Austin chalk and the limestones of the Fredericksburg group (Goodland limestone to the north and Edwards limestone and Comanche Peak limestone to the south). The Austin chalk is massive white, friable, chalky limestone. It is several hundred feet thick and carries from 70 to 90 per cent of carbonate of lime and generally less than three-fourths of 1 per cent of magnesium carbonate. The silica is variable, and in places increases in quantity as the lime carbonate decreases. The limestones of the Fredericksburg group are situated west of and generally parallel to the outcrop of the Austin chalk. They occur in large areas in Wise, Parker, Hood, Erath, Bosque, Hamilton, Coryell, Lampasas, Burnet, Blanco, Kendall, Comal, and Bexar counties. Large areas are exposed in the Edwards Plateau west of San Antonio. North of the Brazos River valley they are represented by the Goodland limestone, a massive, semicrystalline, white limestone 30 to 50 feet thick. From the Brazos River valley southward they gradually increase in thickness, reaching 300 feet on Colorado River. In central Texas the lower part is a massive white chalky limestone nearly 100 feet thick (Comanche Peak limestone), and the upper part is composed of thick beds of nearly pure chalky and siliceous limestone alternately stratified (Edwards limestone). These siliceous beds contain quantities of nodular and almost pure flints.

Limestone has been produced from 64 quarries in Texas within the last three years, 29 of which produce stone for lime. These quarries are distributed among 31 counties. By far the greater part of the output of limestone not used for making lime is sold as crushed stone for macadam, ballast, and concrete.

[1] Burchard, E. F., Structural materials available in the vicinity of Austin, Tex.; U. S. Geol. Survey Bull. 430, pp. 299–303, 1910.

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Marble.—True marble is found in Mason County, central Texas, and in several counties of trans-Pecos Texas, and beds of crystalline limestone susceptible of a good polish are found in many other parts of the State. Dumble [1] states that among the true marbles of Mason County are beds that are snowy white and of even grain. From the Carrizos to the Quitman Mountains outcrops of fine-grained marble occur in the vicinity of the railroad, and include white as well as banded and clouded varieties. Bluish limestone probably of Lower Ordovician age outcropping at Marble Falls, Burnet County, is of a dense subcrystalline character, and will doubtless take a good polish. Other varieties of nonmetamorphosed marble are reported to occur elsewhere in Burnet County, and in Llano, San Saba, Gillespie, and other counties, and many of them are well adapted for interior decorative purposes. Certain quarries in areas of Cretaceous and Tertiary rocks, remote from any intrusive rocks, report the production of marble which is in reality limestone susceptible of receiving a good polish. The fossiliferous Cretaceous limestone at Austin, known locally as the "Austin marble," is to be classed as such.

MONTANA

Limestone.—Limestone is found chiefly in the mountainous western part of Montana, where it occurs in great abundance along the flanks of the mountain ranges. In the Plains region, which comprises the eastern two-thirds of the State, the formations are mostly of Cretaceous age, except in the local uplifts of the Little Rock, Judith, and Snowy Mountains. The Cretaceous formations contain lenses and concretions of limestone which are available for burning to quicklime. In the mountainous regions the limestones are mainly of Paleozoic age, and the principal limestone-bearing series is the Mississippian, whose massive beds flank the great ranges of the State. Devonian and Silurian limestones are impure and the Cambrian limestones are thin bedded and generally irregular in composition. Limestone beds outcrop along the northern slope of the mountain front from Red Lodge, in Carbon County, westward to Livingston, northward about the flanks of the Bridger, Little Belt, and Belt ranges to the Main Range west of Great Falls. Practically all the southern ranges of the western part of the State are uplifts with cores of gneiss or granite mantled by limestones of various ages. Such rocks occur westward almost to the Bitterroot Valley. Deposits of interesting limestones occur about 5 miles south of Havre. These limestones are notable because the action of igneous intrusions has produced in them considerable wollastonite, a natural lime silicate.

Limestone is quarried in 12 counties in Montana, a total of 23 quarries having been enrolled as producers in recent years. At 12 of these quarries in 8 counties, the stone produced was used for the manufacture of lime. Over two-thirds of the value of the limestone output came from sales of stone for smelter flux, although much of the limestone that is now produced in Montana is burned into lime that is used in the refining of beet sugar. Analyses of limestones quarried in Carbon, Cascade, Gallatin, Jefferson, Lewis and Clark, and Park counties were published in Mineral Resources for 1911, Part II, page 675. Nearly

[1] Dumble, E. T., Building stones of Texas: Stone, vol. 5, p. 567, 1892.

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all these rocks, especially those that are high in calcium carbonate, are used in beet-sugar factories.

Marble.—The production of marble has recently been reported from quarries in Gallatin and Lincoln counties. No data are at hand as to the character of the Lincoln County rock. According to Rowe[1] the marble near Manhattan, Gallatin County, is similar to Mexican onyx and takes a splendid polish. He states that marble has also been quarried in Nelson Gulch, 6 miles southwest of Helena, and at Dempsey Creek, Powell County. The deposits in Nelson Gulch are reported to show seven distinct varieties of marble, including white statuary marble, marble for monumental work, and blue marble suitable for building.

WYOMING.

Limestone.—There are thick and extensive deposits of limestone in the Paleozoic and Cretaceous formations in Wyoming. The Paleozoics lie on the flanks of the crystalline rock masses of the mountains and the Black Hills. The Cretaceous beds border the Paleozoics around the mountain uplifts. Quarries have been opened from which stone for the manufacture of lime and for use in beet-sugar refining is obtained, as well as crushed stone for ballast and concrete. Many of these limestones, especially those found in Albany, Carbon, Laramie, and Weston counties are nearly pure calcium carbonate. Analyses of several of these limestones were published in Mineral Resources for 1911, Part II, pages 697–698. Ten quarries in six counties produce limestone in Wyoming. The bulk of the output goes to beet-sugar factories, some of which are in other States.

Marble.—Marble has been reported from several places in Wyoming. In Muskrat Canyon fine-grained reddish marble, variegated with white and drab colors, as well as pink marble of uniform color are reported to occur. White and greenish marbles of good quality are reported to occur in Cedar Creek in the eastern part of the Platte River valley. White crystalline limestone or marble with mossy veining is reported to occur about a mile west of the railway near Iron Mountain station. It has been suggested by Darton[2] that possibly limestone in the upper part of the Madison limestone (Mississippian), in the Bighorn Mountains might be worked for marble. A deposit near Hartville is reported as a possible future marble producer.

COLORADO.

Limestone.—The limestones of Colorado may conveniently be divided geographically and geologically into two groups. The first of these groups includes limestone mostly of Cretaceous age, which occurs in the Plains region of the eastern half of the State and in a narrow belt immediately east of the Front Range. The second group includes the limestones mostly of Carboniferous age, which lie west of the Front Range. The two limestone formations of greatest importance in the Cretaceous system are the Niobrara and the Greenhorn. The Niobrara outcrops as a narrow but fairly continuous belt

[1] Rowe, J. P., Some economic geology of Montana: Montana Univ. Bull. 50, Geol. ser. No. 3, pp. 48–49, 1908.
[2] Darton, N. H., Geology of the Bighorn Mountains: U. S. Geol. Survey Prof. Paper No. 51, p. 115, 1906.

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from the Wyoming line southward to Colorado Springs, passing just west of Fort Collins and Denver. South of Colorado Springs are two areas of limestone of Niobrara age, which occupy much of Pueblo, Otero, Huerfano, Las Animas, Bent, Prowers, Kiowa, and Cheyenne counties, the upper area of outcrop lying along Arkansas River, from near Florence to the Kansas line. The thickness of the Niobrara is about 400 feet, but calcareous shale makes up a considerable part of this thickness.

In central and western Colorado limestones of Mississippian age cover large areas. Analyses of limestones from a number of points in Garfield, Grand, Gunnison, Jefferson, Park, Pitkin, and Summit counties indicate that they are low in magnesia.

The abundance of easily worked sandstone, as well as the suitability of much of the granite for building purposes in Colorado, has retarded the development of any of the limestone beds in this State for building purposes. Such limestones as are used as building stone are of the crystalline variety and are classed as marble. For chemical uses and the manufacture of lime the limestones of Colorado are much in demand. Limestone is quarried in 13 counties in Colorado, 8 of which produce lime, and a large output is recorded.

Marble.—Marble deposits have been known in several counties in Colorado for more than 30 years, but only within the last six or seven years has any important development taken place. Merrill [1] states that a specimen of handsome black, white-veined breccia marble has been sent to the National Museum from Pitkin; that a chocolate-colored marble is reported to occur near Fort Collins, and a breccia marble near Boulder. According to records of the Colorado State School of Mines, Denver, 1884, a white dolomitic marble is reported from Calumet, Chaffee County. A yellow marble stated to resemble the famous Siena marble of Italy has been reported to the Survey from near Canon City.

The most extensively developed deposits of marble in Colorado are on Yule Creek, in northern Gunnison County. The deposits that are quarried here are high on the left bank of the creek and dip westward at an angle of about 52°. The marble bed is reported to be about 240 feet thick and to contain four bands of chert each 2 to 4 feet thick. The underlying rock is cherty blue dolomite, and overlying the marble is a sill of igneous rock which is, in turn, overlain by 500 to 800 feet of blue cherty limestone. The marble itself is for the most part white and of medium fine grain, but there are bands of handsome green-stained material within the mass. This quarry has a complete equipment and has maintained a large output of marble for several years. The rock is carried to the mill at Marble, about 3½ miles distant by an electric tramway. At the marble mill, which is electrically driven and is one of the most completely equipped in the United States, the product is sawed, planed, turned, polished, carved, and otherwise prepared for all kinds of interior and exterior construction work. This white marble has been used for interior decoration in the Cuyahoga County courthouse at Cleveland, Ohio, in the Chessman Park shelter house, Denver, Colo., in office buildings at Salt Lake City, and elsewhere, and is being used in the Lincoln Memorial Temple at Washington, D. C.

[1] Merrill, G. P., Stones for building and decoration, p. 208, 1903.

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NEW MEXICO.

Limestone.—Limestone of the Cambrian, Ordovician, Carboniferous, and Cretaceous systems occur in New Mexico, although little is known concerning their chemical and physical properties, except where they have been studied in connection with metalliferous and coal deposits. In the vicinity of Carthage, Socorro County, the Pennsylvanian San Andreas limestone has a thickness of about 200 feet and outcrops within half a mile of a railroad. Limestone quarries are situated in 8 counties, of which 6 have produced stone for the manufacture of lime. The output of limestone other than for lime is used for railroad ballast and concrete.

Marble.—Marble, which is also widely distributed in New Mexico, has been reported as quarried in the following counties: Grant, Guadalupe, Lincoln, Luna, and Otero. Only a small production is maintained at present, since most of the quarries are idle.

WESTERN AND PACIFIC COAST STATES.

The literature and unpublished data available on the limestone and marble deposits of the United States west of the Rocky Mountains is so fragmentary that it is not practicable to construct at this time even a reconnaissance map of these rocks. There is presented, however, elsewhere in the current volume of Mineral Resources (in the chapter on the stone industry in 1913), a discussion of these resources by States, and the stone quarry maps accompanying that chapter show the location of all limestone and marble quarries and limekilns.

CHARACTER OF LIME PRODUCED IN VARIOUS STATES.

The following tabular outline indicates, by States and counties, whether high-calcium or magnesian lime, or both, is being burned in a given locality:

Character of lime produced in the United States in 1913, by States and counties.

State or Territory.	County.	
	High-calcium lime.	Magnesian lime.
Alabama	Blount	Colbert.
	Calhoun	Shelby.
	Dekalb	
	Etowah	
	Jefferson	
	Madison	
	Shelby	
Arizona	Coconino	
	Yavapai	
Arkansas	Benton	
	Izard	
	Washington	
California	Amador	Siskiyou.
	Contra Costa	
	Eldorado	
	Kern	
	Mono	
	Placer	
	San Benito	
	San Bernardino	
	Santa Cruz	
	Shasta	
	Siskiyou	
	Tuolumne	
	Ventura	

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Character of lime produced in the United States in 1913, by States and counties—Contd.

State or Territory.	County.	
	High-calcium lime.	Magnesian lime.
Colorado	Chaffee	Boulder.
	Douglass	Fremont.
	Fremont	La Plata.
	La Plata	
Connecticut	Fairfield	Fairfield.
		Litchfield.
Florida	Marion	Marion.
Georgia	Walker	Bartow.
Hawaii	Hawaii	
Idaho	Bannock	Cassia.
	Bear Lake	Lemhi.
	Cassia	
	Kootenai	
	Lemhi	
	Nez Perce	
	Oneida	
Illinois	Adams	Cook.
	Carroll	Kankakee.
	Madison	Rock Island.
	Will	Whiteside.
		Winnebago.
Indiana	Bartholomew	Bartholomew.
	Carroll	Huntington.
	Crawford	Jay.
	Harrison	Jefferson.
	Lawrence	
	Ripley	
	Washington	
Iowa	Cerro Gordo	Dubuque.
	Clayton	Jackson.
Kansas	Elk	Shawnee.
	Leavenworth	
Kentucky	Breckenridge	Meade.
	Meade	Warren.
	Rockcastle	
	Scott	
	Warren	
Maine	Knox	Knox.
Maryland	Allegany	Allegany.
	Baltimore	Baltimore.
	Carroll	Carroll.
	Frederick	Frederick.
	Garrett	Garrett.
	Howard	Washington.
	Washington	
Massachusetts	Berkshire	Berkshire.
Michigan	Alpena	Bay.
	Arenac	Emmet.
	Bay	Menominee.
	Charlevoix	Schoolcraft.
	Cheboygan	
	Emmet	
	Mackinac	
	Schoolcraft	
	Wayne	
Minnesota	Mower	Blue Earth.
	Scott	Goodhue.
Missouri	Callaway	Cole.
	Cape Girardeau	
	Cooper	
	Dade	
	Franklin	
	Greene	
	Jasper	
	Jefferson	
	Lawrence	
	Marion	
	Miller	
	Osage	
	Pettis	
	Pike	
	Ralls	
	St. Clair	
	St. Genevieve	
	St. Louis	
Montana	Deerlodge	Madison.
	Powell	Park.
Nevada	Lyon	

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Character of lime produced in the United States in 1913, by States and counties—Contd.

State or Territory.	County.	
	High-calcium lime.	Magnesian lime.
New Jersey	Hunterdon	Hunterdon.
	Sussex	Somerset.
	Warren	Sussex.
		Warren.
New Mexico	San Miguel	Grant.
		San Juan.
		Santa Fe.
New York	Clinton	Albany.
	Fulton	Dutchess.
	Genesee	Jefferson.
	Herkimer	Orange.
	Jefferson	Ulster.
	Lewis	Westchester.
	Livingston	
	Monroe	
	Niagara	
	Onondaga	
	St. Lawrence	
	Ulster	
	Warren	
	Washington	
North Carolina	Columbus	Swain.
	Craven	
	Henderson	
	Yadkin	
Ohio	Delaware	Belmont.
	Erie	Clark.
	Holmes	Greene.
	Marion	Hardin.
	Ottawa	Montgomery.
	Preble	Ottawa.
	Stark	Sandusky.
	Tuscarawas	Seneca.
		Wood.
		Wyandot.
Oklahoma	Coal	
	Delaware	
Oregon	Baker	
	Jackson	
	Josephine	
	Wallowa	
Pennsylvania	Adams	Armstrong.
	Armstrong	Bedford.
	Bedford	Berks.
	Berks	Chester.
	Blair	Cumberland.
	Bucks	Dauphin.
	Butler	Franklin.
	Center	Huntingdon.
	Chester	Jefferson.
	Clarion	Juniata.
	Clinton	Lancaster.
	Columbia	Lawrence.
	Cumberland	Lebanon.
	Dauphin	Lehigh.
	Fayette	Lycoming.
	Franklin	Monroe.
	Huntingdon	Montgomery.
	Jefferson	Montour.
	Juniata	Northampton.
	Lancaster	Northumberland.
	Lawrence	Perry.
	Lebanon	Union.
	Lycoming	Westmoreland.
	Montgomery	York.
	Montour	
	Northampton	
	Northumberland	
	Perry	
	Snyder	
	Somerset	
	Union	
	Westmoreland	
	York	
Rhode Island		Providence.
South Dakota	Custer	Meade.
	Lawrence	
	Meade	
	Pennington	

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Character of lime produced in the United States in 1913, by States and counties—Contd.

State or Territory.	County.	
	High-calcium lime.	Magnesian lime.
Tennessee	Carter	Rhea.
	Coffee	
	Cumberland	
	Davidson	
	Dickson	
	Franklin	
	Houston	
	Knox	
	Lawrence	
	Montgomery	
	Rhea	
	Union	
	Washington	
Texas	Comal	Coryell.
	Coryell	El Paso.
	Dallas	Tarrant.
	El Paso	
	Nolan	
	San Saba	
	Travis	
	Williamson	
Utah	Cache	Cache.
	Salt Lake	Salt Lake.
	Sanpete	Wasatch.
	Sevier	Weber.
	Utah	
	Wasatch	
Vermont	Addison	Windsor.
	Chittenden	
	Franklin	
	Rutland	
	Windham	
Virginia	Augusta	Augusta.
	Botetourt	Frederick.
	Frederick	Loudoun.
	Giles	Montgomery.
	Montgomery	Rockbridge.
	Rockbridge	
	Rockingham	
	Russell	
	Shenandoah	
	Tazewell	
	Warren	
	Washington	
Washington	Chelan	San Juan.
	Ferry	Stevens.
	Okanogan	
	San Juan	
	Stevens	
	Whatcom	
West Virginia	Berkeley	Berkeley.
	Greenbrier	Jefferson.
	Jefferson	Preston.
	Preston	Wayne.
Wisconsin	Door	Buffalo.
	Lafayette	Calumet.
	Oconto	Dodge.
	Waukesha	Door.
		Fond du Lac.
		Kewaunee.
		Manitowoc.
		Outagamie.
		Ozaukee.
		Shawano.
		Sheboygan.
		Trempealeau.
		Vernon.
		Washington.
		Waukesha.
Wyoming	Carbon	

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THE MANUFACTURE AND USE OF LIME.

By Warren E. Emley.

GENERAL DISCUSSION.

DEFINITION AND CLASSIFICATION OF LIME.

Strictly speaking, lime is the oxide of calcium. It can be prepared by heating calcium carbonate under such conditions that the compound is decomposed, the carbonic acid is driven off as a gas, and the calcium oxide remains as lime. Calcium carbonate occurs in nature as calcite, which is the main constituent of limestone. It is almost always associated with impurities, such as silica, the oxides of iron and aluminum, and magnesium carbonate. With the exception of magnesia, these impurities may be found in almost any proportions, so that there is no sharp line of distinction between limestone on the one hand and sandstone, cement rock, or clay on the other. Any of these substances can be heated in such a manner that whatever calcium carbonate they contain will be decomposed. This makes it necessary to set an arbitrary limit by stating that the resultant product must contain at least a certain proportion of calcium oxide in order that it may be called lime. The chief physical characteristic of lime is that it will slake when treated with water. The slaking is accompanied by an evolution of heat and an increase in volume, and results in the formation of a plastic putty. It has been found that if the impurities are present in too large proportions this power of slaking is impaired or destroyed. If the ability to slake is considered as a condition which a substance must fulfill in order that it may be called lime, then experience tells us that the product of calcination of a limestone is lime only when the sum of the silica, ferric oxide, and alumina is less than 5 per cent.[1] It has been found that magnesia does not impair the slaking power of the lime seriously and that the presence of this substance improves the quality of the lime for many purposes. From a commercial standpoint, magnesia is not considered as an impurity, and limes are classified according to their composition as follows:

Classification of lime.

High-calcium lime contains 0 to 5 per cent magnesia.
Magnesian lime contains 5 per cent to 25 per cent magnesia.
Dolomitic lime contains 25 per cent to 45 per cent magnesia.
Superdolomitic lime contains over 45 per cent magnesia.

This classification is the one officially adopted by the National Lime Manufacturers' Association. The definitions given by Mr. Burchard conform more nearly to the proper and generally accepted uses of the terms, viz: High-calcium lime is made from stone containing more than 93 per cent calcium carbonate; magnesian lime is made from stone containing 7 per cent or more of magnesium carbonate; dolomitic lime is a special grade of magnesian lime in which the ratio of calcium oxide to magnesium oxide is very nearly 8 to 5.

[1] Glossary of terms: Nat. Lime Mfrs. Assoc. Trans., 1910, pp. 14-24.

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MANUFACTURE.

PROCESS OF MANUFACTURE.

QUARRIES.

QUALITY OF STONE.

The quality of limestone suitable for burning may vary, both chemically and physically, within rather wide limits. Chemical analyses of some samples of stone used for manufacture of lime are given in the accompanying table. They were made under the direction of Mr. P. H. Bates, chemist, by Mr. A. J. Phillips, assistant chemist, of the Bureau of Standards of the Department of Commerce.

The chemical composition of a lime depends on that of the stone from which it was made. Consequently only those limestones may be used from which a marketable lime can be produced. It must be remembered that on account of the loss of about half the weight of the stone as carbon dioxide during the burning the proportion of every other constituent of the stone will be nearly doubled in the lime. The composition which a lime should have for any given purpose is a much-mooted question and will be fully discussed in the following chapter on the uses of lime.

For the present it may be stated that the presence of a rather large proportion of impurities in the stone is permissible, except where a finishing lime or a particular grade of chemical lime is to be made. The ratio of calcium to magnesium desired depends largely on the market in the particular locality. When the lime is sold for chemical purposes, this ratio will generally be specified.

Chemical composition.—The chemical composition of the stone influences the cost of burning. Experience has shown that it generally requires less heat and a lower temperature to burn a magnesian than a high-calcium stone. The greater the proportion of impurities, the more easily is the lime overburned, and therefore too large a proportion of these constituents will cause a diminution of the capacity of the kiln. It is possible that the proportion of silica may be high enough to form the dicalcium silicate ($2CaO.SiO_2$). This substance when cooled slowly assumes allotropic forms. Thus, at 675° C. (1,247° F.) it charges from β to the γ modification, with a marked increase in volume.[1] This causes the lime to fall to pieces, a phenomenon commonly known as "fire slaking."

From the chemical analyses of the samples of stone collected it will be seen that the quantity of lime varies from 29.77 per cent to 55.56 per cent, and of magnesia from 0.31 per cent to 21.23 per cent, but that the total quantity of both carbonates combined in any stone is never much less than 97 per cent. The silica is occasionally somewhat over 2 per cent without injury to the stone for lime burning, but the alumina and oxide of iron are generally under 0.5 per cent. It must be remembered, however, that this investigation did not cover the entire field, and that limes are produced in which the proportion of impurities is so high that they are practically natural cements.

[1] Day, A. L., and Shepherd, E. S., The lime-silica series of minerals: Am. Chem. Soc. Jour., p. 1089, 1906.

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Analyses of limestones.[a]

Company and location.	No.	Designation of stone.	Silica (SiO_2).	Alumina (Al_2O_3).	Iron (Fe_2O_3).	Calcium carbonate ($CaCO_3$).	Magnesium carbonate ($MgCO_3$).	Total.
Rockland-Rockport Lime Co., Rockland, Me.	1	Soft	1.29	0.15	0.35	95.91	2.27	99.97
	2	Rockport	2.41	.22	.40	85.18	11.72	99.93
Farnam-Cheshire Lime Co., Cheshire, Mass.	3	(b)	.44	.08	.20	98.05	1.30	100.07
Connecticut Lime Co., Canaan, Conn.	4	(b)	.34	.19	.28	58.20	41.16	100.17
New Jersey Lime Co., Hamburg, N. J.	5	McAfee	.85	.06	.20	96.70	2.04	99.85
	6	Hamburg	1.21	.41	.45	95.70	2.25	100.02
	7	West end south quarry.	.81	.56	.47	54.68	43.66	100.17
Chas. Warner Co., Cedar Hollow, Pa.	8	East end south quarry.	.91	.09	.30	63.02	35.78	100.10
	9	North quarry c	2.27	.51	.40	53.16	43.89	100.23
	10	Whiteland	.94	.15	.45	54.09	44.58	100.21
Lowell M. Palmer Co., York, Pa.	11	White	.53	.04	.05	99.21	.74	100.57
	12	Blue	.14	.02	.10	98.73	1.01	100.00
American Lime & Stone Co., Bellefonte, Pa.	13	Calico	.27	.07	.30	86.43	12.98	100.05
	14	Quarry No. 13	1.41	.25	.40	96.36	1.55	99.97
Thomasville Stone & Lime Co., Thomasville, Pa.	15	(b)	.15	.10	.15	99.02	.57	99.99
Riverton Lime Co., Riverton, Va.	16	Slaty	.42	.07	.32	97.20	2.02	100.03
	17	Oily	.36	.07	.22	96.07	3.26	99.98
	18	(b)	.46	.06	.20	89.20	10.14	100.06
E. Dillon's Sons, Indian Rock, Va.	19	Lower quarry	.28	.16	.20	98.50	.78	99.92
	20	Upper quarry	.80	.10	.35	97.05	1.72	100.02
	21	Fertilizer d	1.06	.40	.55	96.21	1.76	99.97
Tennessee Marble Lime Co., Knoxville, Tenn.	22	Main quarry	.16	.13	.06	98.93	.76	100.04
	23	Other quarries	.23	.08	.20	98.25	1.26	100.02
	24	Luttrell	.65	.05	.30	84.50	14.53	100.03
Legarde Lime & Stone Co., Legarde, Ala.	25	(b)	1.64	.33	.31	94.39	3.42	100.09
Ash Grove White Lime & Portland Cement Co., Ash Grove, Mo.	26	(b)	.10	.....	.05	99.05	.88	100.08
Glencoe Lime & Cement Co., Glencoe, Mo.	27	Gray	.32	.13	.30	98.29	1.05	100.09
	28	Blue	.21	.06	.15	98.89	.67	99.98
	29	Brown	.26	.02	.20	98.84	.65	99.97
	30	White c	1.35	.53	.40	94.89	3.05	100.22
Marblehead Lime Co., Marblehead, Ill.	31	(b)	.21	.04	.10	98.45	1.28	100.08
Sheboygan Lime Works, Sheboygan, Wis.	32	(b)	.55	.24	.40	55.09	43.91	100.19
Union Lime Co., High Cliff, Wis.	33	(b)	1.12	.06	.40	54.82	43.79	100.19
White Marble Lime Co., Manistique, Mich.	34	Manistique c	1.92	.03	.30	54.04	43.81	100.10
	35	Blaney	1.23	.19	.50	94.38	3.74	100.04
	36	Marblehead	.56	.05	.20	55.00	44.31	100.12
	37	Indian Dam	1.04	.05	.25	54.25	44.52	100.51
Woodville White Lime Co., Woodville, Ohio.	38	(b)	.34	.02	.15	56.79	42.92	100.22

[a] For a more extended tabulation of analyses of limestones and limes, see Burchard, E. F., The production of lime in 1911: U. S. Geol. Survey Mineral Resources, 1911, pt. 2, pp. 658–707, 1912.
[b] Average of stone burned for lime.
[c] Not burned for lime.
[d] Burned for fertilizer only.

Physical properties.—So far as its physical properties are concerned, any kind of limestone is suitable for burning. These properties do, however, influence the cost of production to a noticeable extent. Experience has shown that fine-grained, dense stone can be burned at a lower temperature and with less heat than one which is coarsely crystalline and porous. Coarsely crystalline stones, especially if very pure, are apt to fall to pieces in the kiln, thus reducing the production of lump lime. The same occurrence is sometimes noticed when a porous stone is used, although in this case it is probably due to the rapid expulsion of water from the pores. On the other hand, laboratory work done by the Bureau of Standards

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indicates that "all naturally porous stones lost their carbon dioxide at a lower temperature, 900° C. (1,652° F.), than the denser materials."[1] Why these laboratory results are contradicted in practice is a subject for future investigation, and is probably dependent upon the size of the pieces of stone, the quantity of material used, and similar factors.

Whether a limestone is porous or not, its water content is of importance, for this water must be evaporated, with the consequent loss of heat and lowering of kiln efficiency. Moreover, some of the water, in chemical composition with the clayey impurities of the stone, will probably not be given off until the stone has reached a red heat. This will require the stone to remain in the burning zone for a longer time and may therefore reduce the kiln capacity to some extent.

Evidently the first point to be considered in the manufacture of lime is the selection and opening of a suitable deposit of stone. The quality of stone required is noted above. It should be ascertained that the quality is reasonably uniform throughout the deposit and that a sufficient quantity of stone is above drainage level, so that the quarry floor will not be continually under water. Transportation facilities and other details of similar importance should be carefully considered.

QUARRYING.

On account of the extreme variations of limestone deposits it is impossible to formulate any definite rules for quarrying which will apply to all of them. However, a few generalities may be stated.

Thus it is usually true that the quality of the stone throughout the same bed (within a small area) will be more nearly uniform than that from different beds. It is therefore advisable in opening a quarry to follow either the dip or the strike of the beds rather than to cut across them.

If a quarry can be so located that its floor is above the tops of the kilns, the cost of hoisting stone can be eliminated. Where this is not possible, it would seem best to maintain the floor at above the drainage level. From a given area this will render available the maximum quantity of stone which can be obtained without pumping. In some cases the value of real estate is sufficiently high to warrant quarrying stone below drainage level, even though a considerable quantity of water must be pumped. An economical method of handling the water is to drain it into a "water hole" or "sump" and to raise it to the surface by means of a bucket elevator.

Experience seems to indicate that the cost of labor and explosives will be less if the quarry can be worked with a vertical rather than a horizontal face and that a vertical face can be worked to best advantage when about 20 feet high. If it is much higher than this, especially designed methods of quarrying must be employed, or the cost of explosives will be increased. Faces higher than 20 feet can be worked in "benches" or sections, each of which is about the height required.

Stripping.—"Stripping" is the name technically applied by quarrymen to the overburden material which covers a deposit of stone. It

[1] Bleininger and Emley, Burning temperature of limestone: Nat. Lime Mfrs. Assoc. Trans., 1911, p. 77.

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may consist of almost any material, but the substances generally met with in the lime industry are clay, gravel, and impure or weathered limestone. The clay or gravel may be of commercial value, and the impure or weathered limestone is generally marketable as ballast or for road material. However, stone to be used for lime manufacture should be quarried where the stripping is as little as possible. The impure limestone, and more especially the clay, is apt to become mixed with the stone for burning and may thus impair the quality of the lime.

If the beds of stone are nearly horizontal and are covered by clay or gravel of uniform thickness, the stripping may be done by hand digging and hauling in carts, by the use of the plow and scraper, or by means of the steam shovel, according to the thickness of the overburden. If the beds are horizontal, but the country is hilly, it is evident that the thickness of the stripping will vary with the height of the hill. Clay from such a formation can be washed away by hydraulic pressure where a sufficient volume of water is available and drainage is possible. Sometimes, however, this method ceases to be economical, and underground mining of the limestone must be practiced.

One method of mining consists of driving horizontal entrances 18 feet high by 50 feet wide into the face of a quarry, leaving enough stone intact to form a roof and the necessary supporting pillars. In a mine of this type, and in an open pit quarry which is driven downward only, the stone is inclosed on five sides. Consequently, the cost of labor and explosives is much higher in a mine than in a hillside open quarry.

In some localities the beds of stone are steeply tilted and the outcropping edges have been eroded. The stripping in such a place is apt to occur in pockets or cavities which may extend down some distance between the beds. Wherever there are many pockets of considerable size a steam shovel may be employed to advantage.

Drilling.—After the stripping, or overburden, has been removed holes are drilled in the stone preparatory to blasting. This is generally accomplished by means of a common bar drill, operated by steam, compressed air, or electricity. The holes are from 1½ to 2 inches in diameter by from 10 to 26 feet deep, depending upon the available depth of stone. Vertical holes are drilled in a row from 4 to 8 feet back of the working face of the quarry and from 5 to 15 feet apart. The distance between holes is governed by the hardness and bedding of the stone and by the fineness to which it is desired to shatter it.

Compressed air is very well suited for this purpose. The air compressor may be installed in the central power plant, since there is very little loss during the transmission to the quarry. The air may be carried by a 4-inch or 6-inch pipe, from which it can be distributed to the drills by 1-inch leads. It is generally compressed to 90 pounds pressure.

Electricity has many economical advantages over compressed air. The loss of power during transmission is less. The current may be used for other purposes besides drilling. Time will be saved, because in moving a drill from place to place, it is necessary merely to connect another length of wire instead of being obliged to cut and fit pipe. When a blast is made, pipes are apt to be covered up or damaged, but

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wires can easily be moved out of the way. A common type of electric drill consists merely of an ordinary bar drill operated by a small electric motor which is supported on the tripod of the drill.

On the other hand, steam would seem in most instances to be the least economical power for drills. If the quarry is at a distance from the kilns, steam can not be generated economically in a central power plant on account of the high cost of transmission; therefore a boiler for this especial purpose must be maintained at the quarry. This entails extra labor and handling of fuel, and even then the loss of power in the pipes leading to the drills is apt to be very large on account of loss by radiation, condensation, and freezing when not in use.

Recently the well drill has replaced the bar drill in many large operations. The holes made are 4 to 6 inches in diameter by as much as 80 feet deep. These can be placed much farther apart than the smaller holes; the quantity of rock thrown down at one blast is generally much larger, and it is not necessary to blast so frequently.[1]

Blasting.—It is the general practice in quarrying stone for the manufacture of lime to blast it loose. Blasting also serves the purpose of breaking the stone to pieces small enough to be put into the kiln. Based on these two purposes, two methods of blasting are in common use—by one method, the stone is merely loosened and thrown down into the quarry in blocks; by the other, it is shattered to pieces small enough for immediate use. The difference in operating by these methods is in the number and position of the holes and the kind of explosive used. The more finely the stone is to be shattered the closer must the holes be to one another and to the working face and the more powerful must be the explosive.

The first method requires less explosive for the first blast, but the large stones thrown down must be drilled and blasted separately, so that this method probably requires in the end more labor and explosive than the second. On the other hand, the second method produces a great deal more fine stuff than the first. However, this is no great objection if a crusher is provided to take care of it. These considerations seem to favor the second method of blasting.

The selection of the explosive to be used depends on the nature of the stone and the method of blasting desired. For a very soft stone, or if the stone is to be taken out in large pieces, a large amount of a weak explosive, such as black powder, would answer the purpose. If the stone is hard or if it is desired to shatter it, 40 per cent dynamite is the explosive in general use.

It is often the practice to "spring" the holes before blasting. This is done by charging them with black powder, not in sufficient quantity to loosen the rock. When this is set off, it springs or enlarges the ends of the holes into chambers, thus giving room for a large charge of explosive for the regular blast. Since more explosive may be used in each enlarged hole, it follows that a smaller number of holes are required to blast out a given mass of rock. That is, the method of springing the holes saves drilling, but costs more for explosives. It is therefore probably more economical for hard rock, but less for soft rock than the ordinary method of blasting.

[1] Russell, S. R., Well drill hole blasting: Nat. Lime Mfrs. Assoc. Trans., 1912.

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Sorting and loading.—After the stone has been blasted loose and thrown down into the quarry, the larger blocks are broken up with dynamite. This is generally placed in holes drilled in the blocks, but may simply be laid on top of the stone and covered with mud. The former method is called "pop shooting" and the latter "mud capping." Pop shooting requires more labor and power than mud capping, but saves so much in the cost of dynamite that the latter method has been abandoned except in quarries where steam drills are used.

The stone is then broken still smaller by sledging, until it is reduced to the size necessary for charging into the kilns. It is then loaded into the car, cart, or wheelbarrow which takes it out of the quarry. This loading is generally done by hand, so as to give an opportunity for sorting the stone.

Limestone must be sorted in order that only the proper quality and size of stone may be put into the kiln. The quality of stone required for burning has already been described. A quarry should be so located and operated as to give as little unsuitable stone as possible. If some "bad" stone must be quarried with the good, its appearance should form a clear indication of its character; otherwise it can not be sorted out, and a poor quality of lime may result. If the lime is to be used for finishing purposes, particular attention must be paid to sorting the stone, since any considerable quantity of clay adhering to the surface of an otherwise good stone is apt to produce an inferior lime.

The size of the stone to be used depends on two considerations—(1) the tendency of stone to fall to pieces; (2) the amount of draft available. A hard, dense stone may be used in smaller sizes than one which is soft and has a tendency to fall to pieces in the kiln. If the draft is normally rather low, large stone should be used, or the draft may be choked below its economical limit. It is the general custom to use everything from a "one-man" stone (a stone as large as one man can readily handle) down to pieces about 4 inches in diameter. On account of more nearly uniform draft it would probably give greater kiln efficiency if the stone were sorted more nearly to the size required by the kiln, but this is hardly economical unless a market for crushed stone is at hand, so that good use may be made of the smaller sizes.

METHODS OF TRANSPORTATION.

The methods in use for taking the stone from the quarry to the kilns are numerous. This is to be expected, since the method must be varied to suit the particular conditions of each plant, such as the distance between the quarry and the kilns, the shape of the quarry, the elevation from the quarry floor to the top of the kilns, and the quantity of stone to be handled. An enumeration of the methods used includes wheelbarrows, carts drawn by horse, cars drawn by horse, cable, or locomotive, cars or buckets transported by aerial cables, and skips hoisted by derricks. It is frequently the custom to use two or more of these methods in combination.

The transportation of stone may be considered as being carried out in three stages: (1) Taking the stone out of the quarry, (2) taking it from the quarry to the kilns, (3) elevating it to the top of the kilns.

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The wheelbarrow has the advantage over all other vehicles, except the cart, in that its direction of action is unlimited, that is, it can follow the constantly shifting working face of the quarry. However, taking stone out in a wheelbarrow is a very slow and laborious process and is certainly not to be recommended, even where the quantity of stone to be moved is very small. Wheelbarrows are sometimes used for elevating stone to the top of the kilns, but only if the charging doors are too small to admit a whole carload.

The horse and cart has the same unlimited action in the quarry as the wheelbarrow. If the distance to the kiln is not too great, this vehicle may be used for the transportation; and there are quarries where the grade is sufficiently low for the horse to haul the stone to the top of the kilns. The method is very slow, however, and is not to be recommended where any considerable quantity of stone must be moved.

Tramcars labor under the disadvantage of requiring tracks. These tracks must be extended and shifted to keep up with the working face, and they must be moved every time a blast is made. If the kilns are very near the quarry, it is the custom to slope the quarry floor, so that the cars can be taken to one point by gravity. Here a cable is hooked on, and they are drawn up an incline to the top of the kilns. If the kilns are more than half a mile from the quarry, it is generally considered economical to use a locomotive for the transportation. If the distance is too short to warrant this but too long for a cable, animal power may be used. Generally it will be found impossible, on account of the grade, for either locomotive or horse to take the stone to the top of the kilns. They deliver it at the foot of an incline, where a cable is attached to pull it up to the top.

The consensus of opinion seems to be that the construction and repair costs of aerial cables are higher than for other methods of transportation. Moreover, they are not adaptable to the changing face of the quarry, so that some other means must be relied on to take the stone to them. They may be necessary in some places, however, as when the stone must be carried over a hill too steep for locomotive or horse, or over a railroad track or some similar right of way.

If the quarry is very deep, sometimes the only possible way to get stone out is by hoisting it. It may be loaded on skips and pulled up by derricks, which load it on cars for transportation to the kilns.

KILNS.

METHOD AND TIME OF CHARGING.

When stone is brought to a kiln by horse and cart the method of dumping it in needs no explanation.

There are two types of cars in general use, bottom-dump and side-dump cars. They are usually built of iron and hold 2 or 3 tons of stone. In bottom-dump cars the bottom consists of two plates so hinged that when released they will swing downward and allow the stone to fall into the kiln. Side-dump cars are built V shaped in cross section, so that they are top-heavy when full of stone and must be fastened to the trucks on both sides. When dumping, the fastening on one side is released and the car is permitted to roll over toward the other side. It must be righted again by hand. An interesting device in this connection is the automatic car. The fastening of this is tripped by an upright piece bolted to the track, the car rolls

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over and discharges its load, and is righted again by springs attached to the trucks.

Some of the kilns visited are charged either by wheelbarrows or by hand. These methods are very slow and laborious, but are used apparently because the design of the kiln makes it impossible to use any other.

It is a well-known fact that when a carload of stone is dumped into a kiln the larger pieces will stay where they strike while the smaller ones will roll away. Thus, when side-dump cars are used much difficulty is experienced because the stone in one side of the kiln is larger than that in the other. This difficulty can be overcome by using bottom-dump cars, which discharge in the center of the kiln; the fine stones roll to the outer edges and tend to check the draft, which is normally greatest there.

The buckets or cars brought to a kiln by an aerial cable are dumped by being lowered till they catch on a horizontal tripping device over the kiln and are upset.

Kilns which are built without hoppers should of course, be filled after each draw. Kilns with hoppers are generally filled once a day, or twice if the quarry and hoisting apparatus have sufficient capacity.

Lime burning is a continuous process. It is generally impracticable to store more than two days' supply of stone in the hopper of a kiln, and it is most economical to run the kiln at full capacity. Thus a steady and reliable stone supply is necessary. Arrangements should be made whereby the kilns will be filled at least once every day.

KILN DESIGN.

Practically all of the lime produced in this country to-day is burned in some form of kiln. What is known as the shaft kiln is used almost universally, although a few attempts have been made to adapt the rotary kiln, so well known in the cement industry. The rotary kiln, although it has many advantages over the shaft type, has the one great disadvantage at present, that the stone must be crushed to a fine size. Therefore the product is not salable as lump lime and can be used only for hydration. The manufacture of hydrated lime is a comparatively new industry, but is growing very rapidly, so that the use of the rotary kiln is fast gaining in favor.

This paper deals only with the shaft kilns, of which there are a great many varieties. In general, a shaft kiln resembles a short, wide stack, of either square, round, or elliptical cross section. It consists of a casing of steel or stone which is lined with refractory material. The long, vertical chamber formed by this lining may be divided into three compartments by imaginary horizontal planes. The top compartment, called the hopper, is used for storing and preheating the stone. Its sides slope in so that the stone may slide down into the middle compartment, the shaft. This shaft is the place where the lime is burned. It may be of either square, round, or elliptical cross section, independently of the outside of the kiln. Generally the sides of the shaft are vertical, although in some cases they slope outward. In this latter method of construction it is customary to omit the hopper. At the bottom of the shaft the third compartment (the cooler) is used for storing the lime after it is burned. The top of the cooler must, of course, have the same cross section as the shaft. The

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sides are drawn in to form a slide leading to the drawing door. A hole in the side or bottom of the cooler is closed by a door or by sheets of iron which swing on a pivot and are known as shears. The lime is removed through this opening. The fuel used in burning the lime is consumed in the fire boxes usually arranged on two sides of the kiln. They are very similar to the common fire boxes in use under boilers. Each kiln has two or more, which are set in openings through the casing and lining into the lower part of the shaft. In this paper the level of the grates in the fire box will be considered the bottom of the shaft, it being assumed that lime is not burned below this point. When gas is used as the fuel, the fire box is a mere port through which the gas pipe is led into the kiln. In either case the draft caused by the combustion of the fuel draws the flame up through this shaft in direct contact with the lime and stone and the gases formed pass out the top of the hopper. To increase this natural draft a stack is sometimes placed on top of the kiln. Forced or induced draft, or a combination of both, is also in common use. The forced draft is generally created by blowing steam through the grates into the fire box; the induced draft by drawing the gas out through the top with a fan. These two methods may be combined, or the gas which is drawn from the top may be forced back through the grates, according to the Eldred process. These methods of increasing the draft have in some cases necessitated closing the top of the kiln. Hence, a charging door must be supplied through which the stone can be dumped.

There are many considerations which limit the practical size of a kiln. Chief of these is probably the market which the kiln has to supply. Lime is a perishable article, hence any cessation in the demand necessitates a curtailment of the supply. If the market demands a definite supply of lime for a continuous period, a kiln can be built large enough to supply that demand. Generally, however, it is safer to build a number of small kilns, so that if the demand falls off, it will not be necessary to close the entire plant. Recently the custom has been introduced at a few plants to run the kilns at full capacity and to hydrate what lime can not be used immediately; for hydrate may be stored. The cross section of the shaft is limited by the distance the heat can be made to penetrate toward the center. The total height of the kiln above the grates is limited by the conditions of the draft. If natural draft is used, the gases must leave the top of the kilns hot enough to produce the draft. That is, the kiln must not be too high, or the stone will absorb too much heat from the gases. With any form of induced draft the kiln should be just high enough for the gases to leave it approximately at the temperature of the external air. If the kiln is lower than this, the heat carried off by the gases is simply wasted; if higher, the added quantity of stone causes unnecessary work for the fan.

What is perhaps the simplest type of kiln recognized by modern practice might be constructed as follows: An outer casing or shell is built up of sections of steel rolled to shape and bolted together, so as to form a stack, say, 10 feet in diameter by 30 feet in height. Inside of the casing, and concentric with it, is erected another stack of fire brick. This may be cylindrical in shape, 6 feet inside diameter by 30 feet high, with walls 18 inches thick. The annular space between the fire brick and the steel is filled with ashes, brickbats, or other similar material, which acts as an insulator to prevent loss of heat by

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radiation, and which also serves to take up the expansion of the fire brick. Two openings in the fire brick stack, opposite each other and about 3 to 5 feet from the bottom, form the inner ends of the fire boxes. These fire boxes extend out horizontally through the steel casing. They are of the ordinary type used for boilers and may be, for example, 4 feet long (from the outer door to the interior of the kiln) by 3 feet wide by 2 feet high (from the grate bars to the top of the arch). The kiln as described is supported on what is known as the firing floor. The bottom of the kiln is closed by a conical steel chamber, known as the cooler, which is hung under the firing floor. This cooler may be 6 feet in diameter at the top by 18 inches diameter at the bottom by 4 feet high. The bottom is closed by the shears previously mentioned and is generally 4 or 5 feet above the cooling floor, so that a wheelbarrow can be placed under the cooler to receive the lime as it is drawn out of the kiln. A kiln of this type, when used to burn a dense high-calcium stone, with a good grade of gas coal, will have a capacity of 8 to 10 tons of burned lime per 24 hours.

The design as given is subject to a great variety of modifications. The form, the dimensions, and even the materials may be changed to meet the peculiar requirements of each plant. Thus, if it is desired to increase the natural draft, a stack may be mounted on top of the kiln. This stack should be connected to the shaft by a conical chamber, so that the gas is not compelled to turn sharp corners which would tend to set up eddy currents and reduce the draft. The size of stack must be so selected that there will be no tendency to throttle the gas. Its dimensions can be calculated by the ordinary formulas for chimney design. For the kiln as described, under ordinary conditions, a stack 20 inches in diameter will have sufficient capacity and will add one-eighth inch of water to the draft for every 35 feet of height. If induced draft, or the Eldred process, is to be used, the top of the kiln should be closed by a flat plate bolted to the casing, in order that the fan will not have a large amount of unnecessary air to handle.

The casing of the kiln is sometimes built of stone or concrete instead of steel. These materials probably diminish the amount of heat lost through the kiln wall, but the casing should be designed primarily for strength. Most of the strain is found to be lateral, which tends to push the stone out. It is resisted much better by steel. Reinforced concrete, when properly designed, should combine the strength of the steel with the heat insulating properties of the stone, and is therefore finding favor in modern construction.

The shaft of the kiln may be built of material other than fire brick. In the burning zone, or that part of the shaft extending 8 or 10 feet above the grates, the brick are subjected to a high temperature (2,200° F. to 2,600° F.) and also to the fluxing action of the caustic lime. In the upper part of the shaft the temperature is low, and the wear is caused mainly by abrasion. A good grade of fire brick will stand the former condition pretty well, but is too soft to resist the abrasion. For this reason the upper part of the shaft is frequently built of cut granite, sandstone, paving brick, concrete, or some equally hard and cheap material. Even a good fire brick in the burning zone will wear out in time, owing to the fluxing action of the lime. It has recently been found that silica brick give longer service under some circumstances.[1]

[1] Seaver, Kenneth, Limekiln linings: Nat. Lime Mfrs. Assoc. Trans., 1914.

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The upper part of the shaft is frequently enlarged to form a hopper. This practice is to be commended, because it gives an opportunity to store a supply of stone, so that the kiln can be operated for a day or two independently of the quarry. Moreover, this stone is stored in such a way that it is preheated, and it requires no further handling. If the kiln has a capacity of 10 tons of lime per day, the hopper should hold 27½ cubic yards of stone, or two days' supply. Care should be taken in designing a hopper that the slope of the sides shall be steep enough to prevent the stone from arching over instead of sliding freely into the kiln.

The shape of the cross section of the shaft need not be circular, but may be square, rectangular, or elliptical. When the products of combustion enter the kiln from the fire boxes they tend to pass upward immediately, along the walls of the shaft. The shaft must be designed so as to force them to penetrate as far as possible toward the center of the kiln. If the shaft is square or rectangular, the corners will form chimneys through which the gases can escape. Obviously, an elliptical shaft gives a larger area with the same distance between the fires than a circular shaft, and this larger area is the cause of increased capacity. The elliptical shaft is therefore the most economical of the four when the capacity of the kiln and the uniformity of the product are considered. The other shapes are frequently used, because they are much cheaper to build and repair. The objections to the circular shape can be overcome by the use of three or four fire boxes instead of two.

The cooler is sometimes lined with fire brick. This retains sufficient heat to complete the calcination of any stone which may have passed through the kiln unburned. The advantage of this process is doubtful, because it necessitates drawing the lime out of the kiln while it is still hot, with the attendant difficulties of handling it.

METHODS OF OPERATING KILNS.

There are two methods in common use for operating lime kilns, which are known as the "following" and the "sticking" processes. By either process only a part of the lime is taken out at a time, since enough must remain to fill the cooler and so keep the unburned stone above the grate level. The "following" method is very simple. When the lime is drawn from the bottom of the kiln the remaining lime and stone slide down and fill up the space, as would naturally be expected. The difficulty with the process lies in the fact that the stone will not burn evenly. Owing to the tendency of the flame and hot gases to pass up the side of the shaft, rather than to go into the center, the mass of unburned stone always extends down farther in th center than at the sides. It is obvious that if the stone falls down evenly, the unburned portion in the center must be brought below the grate level before the burned lime at the sides can be removed from the burning zone. It is the custom to draw out enough lime so that the lowest part of the stone will reach to about the grate level and then take a chance on overburning the lime in front of the fires.

The difficulty just explained may be obviated by the use of the "sticking" process. In this the kiln is generally chilled by omitting to fire and leaving the fire doors open for from 20 minutes to 1 hour before drawing. This chilling causes a contraction of the lining

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and also a solidification of the fused compounds resulting from the action of the lime on the lining. When the lime is drawn from the cooler these two processes acting together prevent the stone from following and cause it to "stick" or "hang." After drawing the lime is knocked down by bars inserted through the fire boxes, and finally the whole mass is caused to fall by knocking the supporting pillar of lime away. By this method the lime can all be removed from the burning zone and an even layer of fresh stone is presented to the fire. It has great disadvantages, however. It requires altogether from half an hour to an hour and a half to complete the drawing, during which time no lime is burned, labor is expended, and the kiln is cooling down. Consequently it is extravagant in time, labor, and fuel.

It must not be supposed that there is a hard and fast distinction between "following" and "sticking" kilns. In general, it may be said that if the sides of the shaft slope outward; that is, if the diameter is larger at the fire than at the top of the shaft, the kiln will "follow;" if straight, it will "stick." A skilled fireman can usually operate any kiln by either process, but sometimes kilns designed to "follow" will "stick," and vice versa. "Following" kilns also have a troublesome habit of "turning over" at times. That is, something will cause a quantity of lime to stick in one part of a kiln while the stone falls down past it, with the result that a layer of lime remains above some unburned stone.

To summarize, the "following" process is probably more economical of fuel, labor, and time than the "sticking" process. But, owing to the less danger of obtaining overburned or recarbonated lime, the "sticking" process probably yields a larger output of more nearly uniform quality. The relative values of the two processes have not been definitely determined.

BURNING.

GENERAL DISCUSSION.

A short theoretical discussion is necessary in order that the conditions required for the economical burning of lime may be comprehended.

There are three factors essential to the process of lime burning: (1) The stone must be heated to the temperature of dissociation of the carbonates; (2) this temperature must be maintained for a certain length of time; (3) the carbon dioxide evolved must be removed.

The physical properties of the stone undoubtedly have some influence on the heat required and on the time in which this heat can be transferred at any given temperature. Thus it will take longer to burn a large piece of stone than a smaller one. A fine-grained dense stone will conduct the heat more readily than one which is coarsely crystalline and porous. The time required to transfer a given amount of heat, roughly speaking, varies inversely with the temperature difference. Therefore it has been found economical to use as high a temperature as possible in order to reduce the time required for burning. The upper limit of the temperature is determined by the phenomenon of "overburning." Overburned lime can be recognized by its yellow color and the extreme length of time it

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takes to slake. These properties are probably caused by a chemical combination of the lime with the impurities contained in it. That this is the case is indicated by the fact that it has been found practically impossible to overburn some limes which are exceptionally pure. Lime may be overburned by being heated for too long a time as well as at too high a temperature. In general it is better to underburn than to overburn the lime, for the unburned stone may be put back into the kiln, but the overburned lime is useless. Moreover, the properties of overburning seem to assert themselves gradually, so that the best lime is obtained by using the minimum amount of heat.

To summarize: A certain quantity of heat must be supplied to dissociate the carbonates in the stone. The quantity varies with the chemical and physical properties of the stone. In supplying this heat it is optional to use either a high temperature for a short time or a lower temperature for a longer time. The temperature used must be higher than 898° C. (1,648° F.) if the decomposition is to take place at atmospheric pressure. The more nearly the amount of heat used approaches the minimum required the better will be the quality of the lime.

It is well known that the chemical reaction involved in burning lime is reversible. That is, calcium carbonate may be decomposed into calcium oxide and carbon dioxide, or these substances may recombine to form calcium carbonate. The factor which determines the way the reaction shall go is the pressure of the carbon dioxide.[1] If this gas is removed as formed so that its partial pressure is kept below that given for the temperature by Johnston's equation, the reaction will continue in the direction to form lime. But if the gas is allowed to accumulate until its pressure becomes higher than this, the reaction will be reversed and will give rise to the phenomenon known technically as "recarbonating." Therefore the prompt removal of the gas is an essential operation in lime burning.

Wood has long been recognized as the best fuel with which to burn lime and is used wherever it can be obtained with any degree of economy. The number of such localities is rapidly growing smaller, so that the problem of using some other fuel is of increasing importance. Experience has shown that wood gives a larger capacity and a better quality of lime, and requires less care in the operation of the kiln than coal. Therefore the tendency of experiments with the latter fuel has been to modify the normal coal fire so that it will to some extent resemble the combustion of wood. A wood fire has three characteristics which distinguish it from a coal fire in its adaptability to lime burning: (1) Its flame is longer. This enables the heat to penetrate farther toward the center of the shaft and creates a larger burning zone. Therefore the capacity of the kiln is greater and the lime tends to burn more evenly, causing less difficulty in the operation. (2) The amount of water generated by burning wood is much greater than that from coal. The pressure of this steam in the products of combustion lowers the temperature required for calcination [2] and thus lengthens the burning zone and increases the capacity of the kiln. (3) The flame from a wood fire is cooler than the flame from coal. This, in connection with the effect of the presence of

[1] Bleininger, A. V., Am. Ceramic Soc. Trans., vol. 9, p. 454, 1907.
[2] Peppel, S. V., Ohio Geol. Survey Bull. 4, p. 294, 1906.

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steam, results in less danger of overburning and a better quality of product.

In all kilns where wood is burned, natural draft has been found satisfactory.

The easiest way of modifying a coal fire so as to cause it to resemble the combustion of wood is to use a mixture of wood and coal. This works successfully wherever tried, but even the small amount of wood needed is not economically obtainable in many localities.

Many lime manufacturers are, therefore, forced, much against their will, to use coal for their fuel supply. The reasons cited above show why the coal fire should be modified to resemble the wood fire, and it may also be added that in many kilns the normal combustion of coal has proved distinctly unsatisfactory for the burning of lime. Experiments on modifying the fire have been mostly confined to different methods of producing the draft.

METHODS OF PRODUCING THE DRAFT.

The following methods for producing draft are in general use: Natural draft; forced draft, caused by blowing steam under the grates; induced draft, created by a fan which draws the gas from the top of the kiln; and the Eldred process, according to which a fan takes the gas from the top of the kiln and forces as much of it as is required back under the grates. In order to determine the relative efficiencies of these processes a number of heat balances were made.

From the results so obtained, the following general conclusions can be drawn: If the lime is drawn hot, or if it is left in the cooler until cold, the heat which it contains will be lost. This heat can be saved and used to preheat the air required for combustion, if this air is taken in through the shears in direct contact with the lime, or through ducts built in the walls of the cooler.

The heat contained in the escaping stack gases can be recovered in part by introducing some of the gas under the grates, as in the Eldred process. The recovery may be more nearly complete if the gases are passed through a boiler or feed-water heater, and their heat used to generate power. If natural draft is relied upon the heat of the gas must be considered as being used to create the draft. It was found, however, that natural draft requires a great deal more heat than any kind of artificial draft. The use of the heat of the gas for this purpose is not to be recommended, therefore, and it would probably be found more economical to build the kiln sufficiently high, so that the heat of the gas would all be taken up by the stone, and to rely upon a fan to furnish the draft.

With good capacity and careful firing the loss of heat due to combustible material in the ash should be very small; by the use of a good gas producer, it should be reduced to a minimum.

The heat lost by radiation and conduction may be considered as emanating from three parts of the kiln—the gas main or fire box, the bottom of the kiln, where the lime is permitted to cool after being burned, and the shaft of the kiln. A study of the designs of the various kilns show that the following methods should tend to reduce the amount of heat lost in this manner. The gas main leading from the producer to the kiln should be short or should be insulated. The comparatively poor gas which it is necessary to use for burning lime

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carries a large part of its energy as sensible heat, and the loss of this heat can be prevented only by introducing the gas into the kiln at the same temperature at which it leaves the producer. Fire boxes will show less loss by radiation when built within the shell of the kiln, rather than externally. A large part of the heat contained in the lime after it is burned will be lost by radiation before the lime is drawn out of the kiln unless means are supplied by which this heat can be recovered and used. Unless the kiln wall is extraordinarily thin or the temperature used extraordinarily high, the loss by radiation from the shaft of the kiln seems to be very small. This can be still further reduced by increasing the diameter of the kiln.

In conclusion, it must be emphasized that the heat efficiency is only one item of the total plant economy. The cost of labor, the ratio of capacity to investment, and the quality of the product must also be considered. Therefore, merely because the figures show a plant to have a high heat efficiency would be no reason for stating that it is the most economical plant.

In the light of the facts brought out by investigation a theoretical discussion of the different methods of producing the draft may not be out of place.

Natural draft, by the use of stacks, can be made sufficient to give good capacity. However, there is grave danger of overburning most stone, for with strong draft the flame may be short and hot. Conditions may easily arise which will force the products of combustion down into the cooler, thus causing recarbonation. Since there is no means of controlling the pressure of gas over the fire, every time the fire door is opened cold air rushes in, which may cause a loss of heat and increase the cost of repairs.

The practice of blowing steam under the grates is obviously one method of introducing the moisture obtained by burning wood. But water content does more than lower the calcination temperature. Part of it is undoubtedly dissociated into its elements while passing through the hot fire. This dissociation takes up heat, which is later given out in the kiln where the elements recombine. Consequently the use of steam tends to cool the fire and produce a longer flame, both highly desirable objects to lime burners. On account of the cooler fire and lower calcination temperature, the capacity of the kiln may be increased with less danger of overburning than when natural draft is used. The forced draft under the grates permits of regulating the pressure above the fire, and therefore the fire door may be opened without admitting enough air to influence the efficiency or repair cost of the kiln. Forced draft does not, however, prevent the products of combustion from going down into the cooler.

This danger of recarbonating the lime can be eliminated by the use of induced draft. When used alone, however, the characteristics of the fire produced by this type of draft have all the disadvantages of a normal coal fire. Since induced draft is created by a fan, any heat carried off by the waste gases is a total loss.

In many kilns a combination of forced and induced draft is used with very good results. The induced draft prevents recarbonation of the lime by removing the carbon dioxide as fast as formed. The forced draft by means of the steam jet gives a cooler fire and a longer flame and also permits control of the gas pressure over the fire. Owing to the lower calcination temperature and the greater rapidity

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of combustion attainable, this method should give the maximum kiln capacity.

Another method of combining the forced and induced draft is according to the Eldred process. For maximum economy the top of the kiln should be closed air tight, and all the gas should be removed by the fan, as in creating induced draft. This fan should deliver as much gas as needed under the grates and should blow the remainder out through a stack. Separate and fairly accurate means of controlling the supply of both air and gas should be provided, and the induced draft created by the fan should be entirely independent of the amount of gas used for the forced draft. As thus installed, many advantages of the combined forced and induced draft may be obtained by using the Eldred process. The induced draft tends to prevent recarbonation and the forced draft permits regulation of the gas pressure over the fire. The fire is kept cool by diluting the air with carbon dioxide taken from the kiln, thus causing a slower rate of combustion. The introduction of an excess of carbon dioxide might be expected to cause recarbonation of the lime, but experience has shown that it does not—probably because the temperature is sufficiently high to prevent the combination. This carbon dioxide also aids by mechanically carrying heat from the fire into the kiln. Moreover, it may act chemically to some extent, since some of it may be reduced to carbon monoxide while passing through the hot fire. This reduction absorbs heat from the fire and liberates it again when the carbon monoxide burns in the kiln in a manner similar to the action of steam. Carbon dioxide does not serve the same purpose as steam, however, for it does not lower the temperature of calcination.

In comparing the two methods—steam and induced draft versus the Eldred process—it must be noted that they both produce a cool fire by mechanically and chemically transferring the heat from the fire box into the kiln. The former method gives a high rate of combustion and a lower calcination temperature, both of which tend to increase the capacity. Owing to lack of oxygen, the Eldred process causes the coal to burn more slowly. This would tend to give a lower output.

In general it may be said that the best method to be used for creating the draft depends on local conditions, chiefly the kind of stone. Thus, if the stone is difficult to overburn, a high output and good quality of lime may be obtained with natural draft. If there is danger of overburning, the forced and induced draft will probably give good results. If there is great danger of overburning or if the lime is apt to act as a flux on the lining, the Eldred process may be used to obtain a good quality of product and keep the repair cost within reasonable limits.

COMPARISON OF COMBUSTION ECONOMY.

Direct combustion.—No mechanical stoker has been perfected which can be adapted to lime-kiln practice; hand firing must be relied upon exclusively. What is known as the coking system of firing has given very good results wherever tried. By this method the green coal is put on a dead plate just inside the fire door, left there until coked, and then pushed back and replaced by a fresh charge. The gases

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distilled from the coal must pass between the fire and the arch and meet with a large amount of air coming through the burned coal at the rear of the fire box. Hence, complete combustion is practically assured. Whether this method is used or not, the economical combustion of gas coal requires that the coal be fired frequently and in small quantities. However, this requires more labor than firing larger quantities at longer intervals, and it is a question of local conditions whether or not the saving of coal would pay for the increased labor.

The heat lost in the waste gases may be increased by two means—the admission of excess air, or the incomplete combustion of the fuel. Of course, it is impossible to regulate the air to exactly the theoretical quantity, and it is always better to have too much than not enough. Incomplete combustion may be caused by not having enough air or by chilling the gases distilled from the coal below their ignition point. To prevent this latter occurrence, the arch of the fire box must be kept hot, and no more air than necessary should be admitted over the fire. In order to overcome these losses of heat the stack gases should be watched closely. If possible the firing should be adjusted according to gas analyses. If this is not practicable, their appearance is a fair indication of their composition. If they are perfectly colorless, it is safe to assume that too much air is being admitted; if black and smoky, the combustion will generally be found to be incomplete. The greatest economy seems to be obtained when the gases have a rather dark-gray appearance.

When a fire is cleaned it is bad practice to draw it completely, since this admits a large quantity of cold air into the kiln and causes a considerable loss of heat. There is a method in use in boiler practice by which one side of a fire is cleaned at a time. This process could be used to advantage by lime burners.

In the preceding discussion of draft, stress is laid on the fact that with forced draft the pressure of the gas over the fire may be regulated. The idea in this is to use forced draft of just sufficient strength to force the air through the fire, and induced or natural draft of a strength very little more than sufficient to pull it into the kiln. By this means the pressure of the gas over the fire may be made very nearly equal to atmospheric pressure. Therefore when the fire door is opened the quantity of air admitted is very small. However, this method causes a slower rate of combustion and lowers the output of the kiln, unless the draft can be increased directly after firing and again checked during firing.

Gas producers.—Instead of modifying the draft to make a coal fire resemble the combustion of wood the coal itself may be modified by converting it into producer gas. The claim for the greater economy of gas producers is based on the lower labor cost and the greater convenience and adaptability of the gas. By adaptability is meant that the fire can be placed where it is wanted. This is especially important in lime kilns, in which coal must be burned in external fire boxes, whereas the gas can be introduced directly into the kiln itself.

All of the producers installed in lime plants generate mixed gas, consisting of the products of distillation, carbon monoxide, and hydrogen. Air is blown through the bed of coal by a steam jet. In such producers, the heat of the coal is used up in four ways,

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namely, in the reduction of the carbon dioxide formed to carbon monoxide, the decomposition of the steam, the distillation of the hydrocarbons from the coal, and the raising of the termperature of the gas. When the gas is burned the hydrogen and carbon monoxide liberate the exact amount of heat taken up by their formation. This, together with the heat generated by combustion of the hydrocarbons, may be called the "potential" heat of the gas. It is evident from the definition that a gas should have practically the same potential heat at the kiln that it had when leaving the producer, but the amount of sensible heat retained depends entirely on the chances for loss by radiation. Therefore, it is imperative to have the producer as near the kiln as possible and to have all gas mains well insulated. Of course, the higher the proportion of noncombustibles in the gas the greater will be the sensible heat in proportion to the potential heat and the more carefully must loss be guarded against. In lime-kiln practice it has been found that a rich gas (one high in combustibles) gives too hot a fire with too great danger of overburning the lime. Therefore, a gas with a large proportion of noncombustibles should be used, and care should be taken to prevent the loss of sensible heat. Another reason for keeping the gas hot is to prevent condensation of the hydrocarbons. These have a high heating value, and the loss of even a small amount of them should not be permitted. It is evident that if the gas is kept hot enough to prevent condensation of the hydrocarbons the potential heat is independent of the temperature; also that if the gas enters the kiln at the temperature at which it leaves the producer the loss of sensible heat will be zero. It should be possible therefore to design a plant so that the use of a poor gas instead of a rich one should make practically no difference in the efficiency of transmission of heat from producer to kiln.

It is customary to mix the gas with air just as it enters the kiln, thus producing combustion in direct contact with the stone. The gas is blown in by forced draft, and steam is one of the chief products of combustion. These considerations indicate that in a gas-fired kiln it should be possible to force the flame farther toward the center, the burning zone should be longer, and the calcination temperature should be lower. Consequently the kiln should have a larger output and should produce a better quality of lime. For a large plant the labor cost should be less. There is, however, the danger of recarbonation, which occurs wherever forced draft alone is used. Care must be taken not to blow in the gas and air so fast that the products of combustion will have any tendency to go down into the cooler.

Gas producers have one decided advantage over methods of direct firing in that a much cheaper fuel may be used; and, although the coal must be low in sulphur to prevent corrosion of the iron, it may be higher in ash and have a lower heating value than the grade of coal economical for direct firing.

Producers may be obtained which are supplied with a device for automatically and continuously feeding the coal and removing the ashes. The fuel bed revolves, so that its depth is kept uniform. Such a producer would cost more to install than the types generally used and would require but little power for its operation. These economic difficulties may be more than counterbalanced by the saving in labor

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and the production of a uniform quality of gas. This last point is of especial importance to lime manufacturers.

If the plant is properly designed, with especial regard to preventing any loss of heat by radiation, and is run by a competent fireman so that the gas is not too rich, is not blown in too fast, and is mixed with very nearly the theoretical quantity of air, the use of a gas producer should prove at least as economical as any method of direct firing of coal.

HYDRATED LIME.

Hydrated lime is a product recently put on the market to take the place of lump lime. As its name indicates, it is lime which has already been hydrated—that is, the chemical combination with the water has already taken place. It is a fine, dry, white powder which is shipped in paper or burlap bags, and which may be used for any purpose instead of lump lime.

The keeping qualities of hydrated lime have been the subject of a great deal of discussion. The original statement which was generally accepted was that hydrated lime would keep indefinitely. On this assumption, samples were tested in their ordinary commercial packages. The average of 11 samples so received showed a content of 3.77 per cent carbon dioxide, and 1 of them contained 10.09 per cent. These figures correspond, respectively, to 8.57 per cent and 22.93 per cent of calcium carbonate or inert material which had presumably been introduced by air slaking in transit. In order to investigate this matter a sample of lime was ground and screened through a 60-mesh sieve, and part of this was hydrated. A sample of the quicklime and one of the hydrated lime prepared from the quicklime and having the same fineness were exposed to the action of the air under the same conditions and were analyzed for carbon dioxide at frequent intervals. The results are as follows:

Analyses of quicklime and hydrated lime.

Age of sample (days).	Percentage of carbon dioxide.	
	Quicklime.	Hydrated lime.
1	0.93	3.14
4	1.68	6.38
6	3.23	7.45
7	3.87	10.34
8	4.02	10.73
10	8.73	11.25

These figures seem to prove that hydrated lime will not keep any better than quicklime of the same fineness. The fineness is important, however, for an impervious coating of air-slaked lime will form on the top of a pile of hydrated lime and prevent access of the air to the interior of the pile.

The chief advantages to the consumer of hydrated lime are as follows: It can be handled more easily on account of its being in powder form. It will keep better than lump lime on account of its fineness. It does not require slaking, but must merely be soaked in

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water to prepare it for use. This saves time and labor and eliminates any danger of loss of lime due to unskilled slaking. Any unburned or overburned lime which has passed the sorter will not hydrate, and can be screened out of the finished product. Hence, hydrated lime should contain less refuse than lump lime. On the other hand, hydrated lime contains 15 to 25 per cent of water, on which the consumer must pay the freight.

Manufacturers reap several advantages from the operation of a hydrate mill. It gives them a product which can be stored, so that in case the orders for lump lime decrease unexpectedly the lime can be hydrated and stored and the kilns need not be shut down. There are several grades of stone in use which burn either to a dark-colored lime or one which falls to pieces in the kiln. Such lime can not be marketed in the lump, but will give a good quality of hydrate.

A very convenient method for testing hydrated lime is to determine its content of carbon dioxide. If properly made and stored, the proportion of carbon dioxide should be less than 1 per cent. Another method which might prove of value as a practical comparative test depends on the density of the the material. Pure calcium hydroxide has a lower specific gravity than any other material which may be present in hydrated lime except water. Of 19 samples of commercial hydrated lime tested by the Bureau of Standards, 8 samples of good high-calcium hydrate showed densities between 2.15 and 2.24; 7 samples of magnesian hydrates showed densities greater than 2.38; the other 4 samples showed densities between 2.34 and 2.38. Two of these four were high-calcium hydrates containing unusually large proportions of silica; one was a high-calcium hydrate with a large proportion of unhydrated (quick) lime; and the fourth was a magnesian hydrate in which the magnesia was hydrated (because of an unusually low temperature used in burning the lime).

MANUFACTURE OF HYDRATED LIME.

Hydrated lime is manufactured on a commercial scale by a process essentially as follows:

Crushing.—Lump lime, as it comes from the kiln, is crushed to pieces 1 inch and smaller in diameter. This is done so that the lime can be handled mechanically, and it also serves to hasten the reaction between the lime and the water.

Hydrating.—The lime is then fed into the hydrator. Theoretically, the only function which this machine has to perform is to mix the lime and the water quickly and thoroughly, in order to prevent the production of a burned hydrate. If there is not enough water present or if the lime and water are not mixed thoroughly, the heat generated by the slaking may be localized and may become so intense that it will change the physical qualities of the hydrate—notably, the plasticity will be diminished.

The hydrators commonly used are of two different types, intermittent or continuous.

The intermittent hydrator consists of a circular iron pan large enough to hold about 1½ tons of hydrated lime and capable of revolving horizontally. Suspended in the center of this pan is a fixed shaft with arms radiating from its lower end. These arms carry plows, which scrape the bottom of the pan, and are arranged in a horizontal

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spiral, so that every part of the pan is touched at least once each revolution. The whole machine is surmounted by a hood and stack to carry the dust out of the building.

In operating the pan it is first started revolving. A definite quantity of crushed lime is then fed in, generally from an automatic weighing bin. Then the water is turned on. The quantity of water used is sometimes regulated automatically by an overflow tank or some such arrangement, but more often it is left to the discretion of the man in charge. If the man is a good operator, the latter method is probably to be preferred. A large proportion of the water added is given off as steam, and the steam generated depends on whether the room is warm or cool, and to what extent the machine has been heated by previous charges. Therefore the quantity of water necessary is not constant and requires supervision. After the water has been added the pan is kept rotating until hydration is complete. This requires from 6 to 20 minutes, according to the quality of lime used. The end of the reaction can be readily discerned with practice. The powder becomes very light and appears dry, and the evolution of steam ceases. A central section of the bottom of the pan is then raised and the plows force the product through this opening into the bin below.

The continuous hydrator consists of a series of long iron tubes, one above the other, to save space. Within the pipes a screw conveyor is arranged which carries the lime through them. The lime is admitted at one end of the top section of the pipe. As close as possible to the end through which the lime enters a large vertical stack is erected. The water is admitted about two-thirds of the way up this stack, and falls down it, over a series of baffle plates, into the pipe. Here it meets the lime. The two sbstances are mixed very thoroughly by the screw conveyor, and at the same time are carried by it through the tube. The conveyor is run at such speed that when the mixture has reached the end of the pipe, hydration is complete. In this machine it is impossible to regulate the quantity of water automatically, on account of the constantly increasing temperature (and consequent evaporation).

A comparison of the two hydrators seems to result in favor of the continuous. First, since the lime and water are admitted in small constantly flowing streams, a quicker and more thorough mixture is obtained. It is much easier to insure the presence of sufficient water for complete hydration; hence the danger of burning is diminished. The stream of water flowing down the stack absorbs the dust. This dust is a serious nuisance around a hydrating plant and makes the labor problem a difficult one. Besides absorbing the dust, the water also condenses the steam generated, and therefore enters the hydrator hot. It is a matter of common experience that a better quality of slaked lime can be obtained with hot water than with cold.

Water.—The quantity of water to be used in making hydrated lime is a very important factor. As already indicated, it must be varied to suit constantly changing conditions, and considerable experience is required to be able to tell by the appearance of the finished product just when the correct quantity has been added. Too much water will cause the product to become pasty and clog the screens. If too little is used more will be later absorbed from the air, with the consequent bursting of the bags in which it is stored. No practical

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means has yet been devised for determining the quantity of water present in the finished product, so that it must be judged merely by its appearance.

Volume.—The hydration of lime is accompanied by an increase in volume which causes the lumps to disintegrate. Evidently, anything which does not hydrate will retain its original lump form and can be separated from hydrated lime by screening.

Screening.—The next step, therefore, is to screen the material which comes from the hydrator. This may be done either by means of a screen or of an air separator. The screen ordinarily used consists of a wooden or metal frame covered with wire gauze of 36 diagonal mesh (36 wires per linear inch, with the diagonals of the square holes running lengthwise of the screen). An air separator is essentially a fan into which the hydrate is fed. The hydrate is picked up by the current of air and carried away, while any impurities settle to the bottom of the fan casing and may be drawn off. The air current passes into a large chamber, which so reduces its velocity that the hydrate settles and the air is taken back and used over again. The air separator has two great advantages over the screen: First, it can be built more nearly dust proof; and, second, it will distribute a hydrate so wet that a screen would be clogged. This permits the use of a little more water in the hydrator, with consequently less danger of burning.

Storage.—The hydrate is now taken to the storage bin, to be kept until ready for packing and shipping. Attention must be called to the extremely disagreeable character of hydrated lime dust. All elevators, conveyers, and bins must be designed to prevent the escape of this dust. Screw conveyers are generally used for horizontal transportation, and bucket elevators, inclosed in boxes built of two thicknesses of matched lumber with a layer of canvas between, are used for vertical transportation.

Packing.—The machine in general use for packing the hydrate in bags consists of a long, narrow, horizontal wooden box, in which is revolved a shaft with pins projecting from it. The hydrated lime flows from the bin into the box. The pins convey it along the box and keep it stirred up to prevent its sticking. Along the bottom of the box are several openings, which may be closed by means of a lever and which when open connect with a long muffle-shaped chute. The bag to be filled is connected to the chute and the lever is raised so that the hydrated lime flows in. The bag rests upon a scale pan, counterbalanced by a weight. When this weight of hydrate has been admitted, the scale pan drops and in so doing pulls down the lever, thus closing the opening in the box and stopping the flow of hydrated lime. The bag is so made that both of its ends appear to be closed, and resemble the bottom of an ordinary bag. In forming the ends the smaller sides are folded over first and are overlapped by the larger sides. One of the smaller sides is left unfastened and through this opening the small muffle-shaped chute is inserted. When the bag has been filled, the pressure of its contents forces the smaller side against the overlapping portions of the larger sides and thus closes the bag. When made of paper such a bag can not be opened without tearing. If cloth is used, the top is made open in the usual manner and is tied before filling. The bag is then filled through a valve in the bottom. This bag gives much less oppor-

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tunity for the dust to get out than a bag which is filled while still open and which must be handled and tied after filling.

CHEMICAL AND PHYSICAL PROPERTIES OF LIME.

Lime, chemically, is the oxide of calcium (CaO), but the commercial article may differ very widely from this composition. It may contain anywhere from 0 per cent to 44 per cent of magnesium oxide, and it generally contains more or less impurities, such as silica and oxides of iron and aluminum. When properly burned and fresh from the kiln, it should contain no water and less than 0.5 per cent of carbon dioxide. If the impurities added by the combination between the lime and the brick lining of the kiln be neglected, the composition of any lime will be essentially the same as that of the stone from which it was burned, minus the carbon dioxide.

The lime will generally retain the same form as the stone, but the porosity is increased very greatly. Lime is nearly white, but it may have a gray, pink, or yellow tinge, depending on the impurities present. Stones in which crystals are apparent frequently retain the same structure after calcination.

When lime is slaked the calcium oxide combines with water to form calcium hydroxide. The impurities may be present in chemical combination with the calcium oxide, in which event they also may take up some water. The manufacturers of hydrated lime judge from the gain in weight of their product that magnesium oxide when burned at the temperature of an ordinary limekiln hydrates very slowly, if at all. Nine samples of magnesian hydrates analyzed by the Bureau of Standards showed an average content of 30.92 per cent magnesium oxide and 2.29 per cent magnesium hydroxide. This peculiarity has been made the subject of scientific research,[1] the conclusions from which are that magnesium oxide will combine with water with reasonable rapidity only when it has been burned at some temperature below 1,100° C. (This is somewhat lower than the temperature of an ordinary limekiln.)

The hydration of calcium oxide generates heat. Since a large part of the magnesium oxide does not hydrate, it acts merely as an inert substance which must be heated by the calcium oxide. Therefore, other things being equal, the less magnesium oxide present in a lime, the more quickly will it slake and the greater will be the heat generated.

The porosity of the lime plays a very important part here, however. Thus, the more porous the lime, the more quickly can the water penetrate it, and hence the chemical combination will take place more readily. Indeed, in some cases the porosity seems to be of more importance than the chemical composition, that is, a very porous magnesian lime may slake more quickly than a dense lime with a much higher content of calcium oxide.

If lime is underburned the calcium carbonate left in it acts as inert matter. Overburned lime exhibits the same phenomenon, although in this case it is probably due to a diminution of the quantity of active calcium oxide present. At the higher temperatures this

[1] Campbell, E. D., On the influence of the temperature of burning on the rate of hydration of magnesium oxide: Jour. Ind. and Eng. Chemistry, vol. 1, p. 665.

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material combines with the impurities, and hence is not free to take part in the reaction of slaking.

The appearance of underburned lime varies with that of the stone, and can be distinguished only by one who has had practice with the particular lime in question. Overburned lime is generally yellow or black in color and can be readily separated from good lime.

When lime is exposed to the air it absorbs water and carbon dioxide, and "air slakes." This reaction takes place in two more or less distinct stages, first, the absorption of water, and second, the displacement of the water by carbon dioxide. Since these reactions are slow, it is possible to obtain lime which has air slaked to almost any degree, and this has led to a great confusion in the literature in regard to the properties of air-slaked lime. For instance at one stage of the process (when the water has been absorbed and has not been displaced to any extent), the product is similar in composition to "water-slaked" or hydrated lime. In order to avoid such confusion, the Bureau of Standards has designated as "air-slaked" lime only that product in which the process has been completed, that is, air-slaked lime must be composed chiefly of calcium carbonate or of a mixture of calcium and magnesium carbonates, and therefore it is chemically similar to natural limestone. Any intermediate product will be designated as partially air-slaked.

The absorption of water during the process of air slaking involves a large increase in volume, and therefore the lumps fall to pieces. This fact gave rise to the demand for "lump lime," the consumer being of the opinion that all fine lime is air slaked. There are several grades of limestone which fall to pieces in the kiln. The stone may be so soft that it is broken up by the abrasion; it may have its pores filled with water, which when heated shatters the stone; or its component crystals may be bound together by organic matter which is consumed in the kiln. Stones like these are burned, and in some cases over 50 per cent of the output of the kiln is fine stuff. Such fine lime is as good for all purposes as lump lime, and it is easier to handle and will keep better. This is obvious from the consideration that the top layer of fine lime will air slake and the crust of inert material so formed will prevent access of the air to the quicklime underneath. The old prejudice against fine lime is rapidly losing ground, as is shown by the fact that some manufacturers are putting crushed lime on the market. The better-keeping qualities of this product are being taken advantage of by some firms, who ship the fine lime in open gondola cars.

The weight of a lump of lime is about 55 per cent of the weight of the stone from which it was burned. Owing to the fact that the lime is in lumps the weight of it which any given volume will contain varies very widely. Thus, a barrel of lime contains from 150 to 350 pounds net in different localities, and a bushel from 32 to 88 pounds.

COMMERCIAL PACKAGES.

Quicklime is put on the market as lump lime (just as it comes from the kiln), or as pulverized lime, which has been ground to any desired fineness. It may be shipped in bulk, in wooden barrels of about 200 pounds capacity, or in iron casks holding 400 pounds.

Hydrate is packed in either 100 pound burlap sacks or 40 pound paper sacks.

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USE OF LIME.

When lime is mixed with water, it will form a plastic putty, which will set or harden on exposure to the air. Also, lime is the cheapest of the alkalies. These two facts have led to the use of lime for a great number of different purposes. These uses may be grouped, so that limes may be classified by means of them into the following four classes:

(1) Building lime, used either alone or with cement in making mortar for masonry work, or for the scratch or brown coat of plaster, or for stucco.

(2) Finishing lime, used either alone or with plaster of Paris for the white coat of plaster.

(3) Agricultural lime, used as a fertilizer.

(4) Chemical lime, used in the various chemical industries.

BUILDING LIME.

MORTAR.

In deciding what lime is the best for making a mortar, we must consider not only the local conditions, such as cost and experience of the laborer, but also three factors inherent in the lime itself: The volume of mortar which it will produce, the ease with which the mortar can be worked, and the strength developed by the mortar when it sets.

The quantity of mortar which a lime will produce varies very widely with the properties of the lime. Thus a pure, properly burned high-calcium lime will produce about 10 cubic feet of putty per barrel (200 pounds) of lime.[1] The presence of any impurities (including magnesia) will decrease the yield of paste. If the lime is either overburned or underburned, the yield will also be decreased. Moreover, the greater the volume of paste, the greater the volume of sand which can be added to it to make a mortar. This is not a direct relation, because the characteristic stickiness of a paste made from a pure high-calcium lime enables it to carry more sand in proportion to its volume than a leaner lime. At any rate, a high-calcium lime will yield the greatest volume of mortar, provided the mortar is properly prepared. If the lime is permitted to burn during hydration, the yield will be materially decreased; and the better the lime, the greater the danger of its burning. The elimination of this danger of burning is one reason why hydrated lime is growing in favor so rapidly. The yield of mortar is obviously a very important factor, because it determines how many pounds of lime will be required to lay a thousand brick.

If we accept the definition of lime as given—that it shall contain not more than 5 per cent of impurities (not including magnesia)—there will be some difference in the working qualities of the putty produced. But when a large quantity of sand is added to make a mortar, any such differences will be hidden. The working quality of the mortar, therefore, need not be considered, provided the lime comes within the definition.

[1] Emley, W. E., Crushing strength of lime mortar: Nat. Lime Mfrs. Assoc. Trans., 1913.

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Mortar made from high-magnesian or "dolomitic" lime will eventually become about three times as strong as that made from a high-calcium lime.[1] If a cubic foot of brickwork weighs 150 pounds, the load imposed on the mortar at the bottom of a wall, due only to the weight of the masonry, will be about 1 pound per square inch for every foot of height of the wall. Evidently, therefore, it is unnecessary to consider the strength of the mortar in most ordinary buildings. If, for any reason, a particularly strong mortar is desired, it is common practice to use Portland cement instead of lime, so that, in any event, the strength of a lime mortar should not be used as a criterion for judging the quality of lime.

In conclusion, therefore, we find that if all other conditions are equal, pure, well-burned, high-calcium lime should be the best for making mortar, because it produces the greatest volume of mortar from a given weight of lime. The deciding factor in choosing a lime for mortar is the experience of the labor in the particular locality, for this will determine the yield of mortar obtained from any given lime.

Obviously, the same conclusions apply to lime used for the scratch or brown coat of plaster.

LIME AND PORTLAND CEMENT.

Although Portland cement gives a strong mortar, it is not very satisfactory for such purposes, because its lack of plasticity makes it rather difficult to work. It has been found that the addition of small quantities of hydrated lime will increase the plasticity without material injury to the other properties of the mortar.

If a cement mortar is sufficiently rich in cement, and the surface is well troweled, it can be made practically waterproof.[2] Unfortunately, the working qualities of the material are such that it is difficult to get a laborer to trowel it sufficiently. The addition of hydrated lime increases the plasticity of the mortar, so that the troweling does not entail so much work. Moreover, the particles of hydrated lime are fine in comparison with the cement and sand, and therefore tend to fill up the voids and produce a denser mortar. For these reasons hydrated lime is looked upon as a waterproofing material.[3]

The use of hydrated lime for this purpose brought about a demand for information toward which a number of investigators have been working. Their conclusions may be summarized as follows: (1) The magnesia in a magnesian hydrate does not act the same as magnesia in the cement itself, but a mixture of cement and magnesian hydrate is stronger at the end of a year than a similar mixture containing high-calcium hydrate.[4] (2) A series of tests made by the Bureau of Standards indicates that cement can be replaced by hydrated lime without material diminution of strength if the ratio of hydrate to cement is less than 1 to 3 by weight. Of course, this conclusion can be applied only to the particular cement used, and it must be noted that the mortars tested were of unusually thin consistency.[5] (3)

[1] Emley, W. E., Crushing strength of lime mortar: Nat. Lime Mfrs. Assoc. Trans., 1913.
[2] Wig, R. J., and Bates, P. H., Tests of the absorptive and permeable properties of Portland cement mortars and concretes: Bur. Standards Tech. Paper No. 3, 1912.
[3] Lazell, E. W., Concrete-Cement Age, March, 1914, p. 130.
[4] Lazell, E. W., Tests of cement-lime mortars: Nat. Lime Mfrs. Assoc. Trans., 1911.
[5] Emley, W. E., Hydrated lime in a Portland cement mortar: Nat. Lime Mfrs. Assoc. Trans., 1914.

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Mortars containing hydrated lime in the proportions of 1 to 3 or less harden better under water than when exposed to air, and some investigators therefore believe it safe to recommend the addition of hydrated lime to cement used for road material or for foundation work.[1]

FINISHING LIME.

A lime to be used as a white coat in plastering must work easily under the trowel, must not pop or pit in the wall, and must be very nearly white. A large yield of putty from a given weight of lime is, of course, advantageous, but can hardly be considered the controlling factor.

In general, it may be stated that magnesian limes work better under the trowel and most of them have a better color than high-calcium limes.[2] The former are therefore to be preferred, even though the latter give the greater volume of putty.

Occasionally the failure of a finishing lime occurs when small particles expand and fall out, leaving pinholes in the wall. This is known technically as "popping" or "pitting." It has been found to be due largely to the presence of lime which has been burned during hydration, that is, to improper slaking of the lime.[3] For this reason hydrated lime is to be preferred to quicklime for finishing purposes. The manufacturer of hydrate should have a better understanding of the problem and is better equipped to prevent the burning during hydration than is the unskilled laborer employed to slake quicklime.

AGRICULTURAL LIME.

The use of lime as a fertilizer dates from the inception of modern scientific farming. Agricultural chemists have shown that there are five or six different functions which lime may perform to benefit a soil, which may be summarized briefly as follows:[4] 1. It is an essential element of plant food. 2. It aids in the conversion of decaying organic matter into humus. 3. It forms compounds with the humic acids which tend to prevent their being leached out of the soil and lost. 4. By producing proper sanitary conditions the growth of injurious bacteria is largely prevented, while the growth of nitrifying bacteria is encouraged. These nitrifying bacteria convert the nitrogen of the humus into a form such that it is available as a plant food. 5. Lime aids in the liberation of potash and phosphorus from inert compounds. 6. It tends to flocculate clay soils, rendering them granular and more porous.

Obviously, permanent results can not be expected unless care is taken to insure the presence of some organic fertilizer at all times. Lime used alone may be temporarily beneficial, but will eventually be harmful; when used with cowpea vines it becomes more efficient for general purposes than almost any other fertilizer.[5] Of course, lime is not beneficial to all crops to the same extent, and not all soils

[1] Spackman, H. S., Effect of hydrated lime on change in volume and strength of mortars and concretes: Nat. Lime Mfrs. Assoc. Trans., 1914; Concrete-Cement Age, March, 1914. p. 112.
[2] Emley, W. E., Tests of commercial limes: Nat. Lime Mfrs. Assoc. Trans., 1913.
[3] Young, S. E., On the popping of lime: Amer. Ceramic Soc. Trans., 1913.
[4] Fippin, E. O., Relation of lime to soil improvement: Nat. Lime Mfrs. Assoc. Trans., vol. 8, p. 78, 1910.
[5] Gardner, F. D., Fertility of soils as affected by manures: U. S. Dept. Agr. Bur. Soils Bull. 48, 1908.

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need lime. Thus, some of the common plants may be classified according to the extent to which they are benefited by lime, as follows:[1]

Plants benefited or injured by lime.

Benefited.	Slightly benefited.	Slightly injured.	Injured.
Spinach	Indian corn	Cotton	Radish.
Lettuce		Tomato	Flax.
Beet		Cowpea	Blackberry.
Celery		Concord grape	Black raspberry.
Onion		Peach	Cranberry.
Cucumber		Apple	
Cantaloupe		Pear	
Asparagus			
Cabbage			
Peanut			
Rhubarb			
Pea			
Pumpkin			
Bean			
Tobacco			
Alfalfa			
Clover			
Barley			
Wheat			
Oats			
Timothy			
Gooseberry			
Currant			
Orange			
Quince			
Cherry			

Whether a soil will respond to liming or not depends on the amount of available calcium oxide which it already contains. Unfortunately chemical analysis does not distinguish between the total calcium oxide and that which is available to plants. Probably the best indication of the need of lime is the failure to obtain a good crop of clover.[2]

Whether high-calcium or magnesian lime should be used as a fertilizer is a question which has received wide attention from agricultural chemists. It is generally conceded that some magnesia is necessary for the growth of most plants, but that too much of it acts as a poison. However, magnesium carbonate is more soluble than calcium carbonate (in the laboratory, 1 part of the former dissolving in about 5,000 parts of pure water, and 1 of the latter in about 10,000 parts of pure water) and therefore may be more apt to be leached out of the soil by rain. Hence most soils contain more calcium than magnesium, and the use of a magnesian lime should be at least not detrimental. This has been found to be the fact.[3] It may be stated that, for the crops ordinarily raised, the lime to be used as a fertilizer should be so selected that the final ratio of lime to magnesia available in the soil should be about 7 to 4.[4]

The question as to whether lime should be applied to the soil as quicklime, hydrated lime, air-slaked lime, or ground limestone is still the subject of a great deal of controversy. The advocates of ground limestone claim that the caustic properties of quick or hydrated lime will burn up and destroy the organic matter in the soil, whereas lime-

[1] Wheeler, H. J., Liming of soils: U. S. Dept. Agr. Farmers' Bull. 77, 1905.
[2] Thorne, C. E., Liming the soil: Ohio Agr. Exper. Sta. Bull. 159, 1905.
[3] Thorne, C. E., loc. cit. Frear, William, Pennsylvania State Coll. Agr. Exper. Sta. Bull. 127, 1913.
[4] Loew, Oscar, and May, D. W., Relation of lime and magnesia to plant growth: U. S. Dept. Agr. Bur. Plant Industry Bull. 1.

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stone can be applied in large quantities at long intervals and will therefore produce a more or less permanent fertility.[1] The advocates of lime claim that one of the main functions which lime has to perform is the destruction of the organic matter and the liberation of the nitrogen in a form such that the plant can use it; that the frequent and judicious use of lime, together with some organic fertilizer, will bring immediate results.[2] Of course the local conditions of each particular case must be considered before a final conclusion can be reached. Thus, it is rational to use quicklime on soils which are exceedingly rich in organic matter, such as peaty or swamp soils.[3] Limestone is safer than quicklime when applied just before planting a crop which is little helped by liming, or when applied to a light sandy soil in hot dry weather.[4]

It will be noted that the value of lime as a fertilizer depends largely on the available calcium oxide which it adds to the soil. This depends partly on the calcium oxide present in the material and partly on the size of the grain, which governs its immediate availability. Pure quicklime contains 100 per cent calcium oxide; pure hydrated lime, 76 per cent; and ground pure limestone, 56 per cent. The farmer must pay the cost of freight, hauling, and distribution on 0 per cent, 24 per cent, or 44 per cent of inert material. It costs least to apply ground limestone and most to apply quicklime. It is generally not economical to grind limestone to the same degree of fineness as burned or hydrated lime. Based on these considerations, the statements have been made that 50 pounds of quicklime are equivalent as a fertilizer to about 60 pounds of hydrated lime, 100 pounds of air-slaked lime, or 250 pounds of ground limestone; and that at present prices, and taking into account the freight and hauling, quicklime will be found the most economical.[5]

CHEMICAL LIME.

Lime has found a wide use in the chemical industries because it is the cheapest base known. Obviously, the kind of lime desired depends on the purpose for which it is to be used and is therefore extremely variable. Thus, for some industries quicklime, hydrated lime, or ground limestone will be found equally suitable. Under some conditions either magnesian or high-calcium limes can be used with equal success; in other cases, the presence of magnesia in large proportions can not be tolerated. For most purposes the silica, iron, and alumina are to be considered merely as diluents, although they sometimes cause mechanical difficulties by forming a sludge which must be removed. If the lime is to be slaked before use and if the heat generated is not essential to the process, it will probably be found more economical to purchase hydrated lime, because it can be stored and handled with greater facility.

The uses of chemical lime are so numerous that it would be impossible to describe all of them, but a few of the more important ones can be outlined briefly.

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[1] Hopkins, C. G., Ground limestone for acid soils: Illinois Univ. Agr. Exper. Sta. Circ. 110, 1907.
[2] Wheeler, H. J., Is the recommendation that only ground limestone should be used for agricultural purposes a sound and rational one?: Nat. Lime Mfrs. Assoc. Trans., 1912.
[3] Hopkins, C. G., loc. cit.
[4] Wheeler, H. J., loc. cit.
[5] Fippin, E. O., Relation of lime to soil improvement: Cornell Univ. Agr. Exper. Sta. Circ. 7, 1910.

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SAND-LIME BRICK.

Sand-lime brick is a building material of growing importance. It consists essentially of a mixture of sand and lime, which is pressed into brick form and then treated with high pressure steam. The lime combines with a part of the sand, forming a calcium silicate, which binds the rest of the sand together. The lime must be completely hydrated before the mixture is pressed, or else the subsequent hydration and expansion will distort or disrupt the brick.

A process has been patented for making sand-lime brick from a magnesian lime, but did not prove successful because it was found impracticable to hydrate the magnesia completely before the brick were pressed.[1] Most of the purchasers of hydrated lime do not demand absolutely complete hydration, so that the manufacturers have not been called upon to give serious attention to this problem. Commercial hydrated lime sometimes contains small percentages of quicklime. For this reason, the manufacturer of sand-lime brick has found it safer to buy quicklime and hydrate it himself.

The presence of small amounts of impurities, especially silica or kaolin, in the lime has been found to be beneficial.[2]

GLASS.

Calcium oxide is a necessary constituent of plate, sheet, and bottle glass, and of a large proportion of the pressed and blown glass. It acts as a flux. Magnesia makes the glass more difficult to melt[3] but is sometimes a valuable constituent when particular optical properties are to be obtained. The calcium oxide is generally introduced as ground limestone, but the use of lime or hydrated lime is sometimes necessary in order to avoid the evolution of gas at high temperatures.

The ordinary impurities of limestone are, in general, of no importance to the manufacturer of common glass. For white glass, however, the content of oxide of iron must be less than 0.3 per cent of the stone.[4]

CERAMICS.

Lime and magnesia, generally as carbonates, are used to some extent as fluxes in the manufacture of pottery and porcelain. It has been found that for wares burned at moderate temperatures, calcium oxide tends to bring the points of vitrification and fusion close together, whereas magnesia tends to separate them, to lower the temperature of vitrification, and to decrease the change of shape due to burning.[5] On the other hand, if the ware is to be burned at higher temperatures, magnesia has little effect on vitrification and fusion and increases the shrinkage.[6] In a series of experiments to determine the values of different bases when used as fluxes for a mixture of feldspar, flint, and clay, it was found that magnesia gave the best results of the five bases tried (oxides of calcium, magnesium,

[1] Field, H. H., Hydrated lime in the manufacture of sand-lime brick: Sand-Lime Brick Assoc. Proc., 1910.
[2] Peppel, S. V., Sand-lime brick: Ohio Geol. Survey Bull. 5, 1906.
[3] Geistharp, Frederick, Fallacies and facts pertaining to glass manufacture: Am. Ceramic Soc. Trans., vol. 12, p. 327, 1910.
[4] Rosenhain, Walter, Glass manufacture, p. 45, Van Nostrand, 1908.
[5] Hottinger, A. E., The influence of magnesia on clays: Am. Ceramic Soc. Trans., vol. 5, p. 130, 1903.
[6] Barringer, L. E., Influence of magnesia on clays: Am. Ceramic Soc. Trans., vol. 6, p. 86, 1904.

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barium, strontium, and zinc). It gave excellent color, high tensile strength, and only moderate shrinkage.[1]

These results all indicate that magnesia is better than calcium oxide as a flux for ceramic bodies.

The carbonates are generally used, since they are the cheapest forms. Levigated natural whiting is preferred on account of high colloidal content.[2]

In some cases, however, vitrification sets in before the carbonates are all decomposed and further evolution of gas may cause pinholing or internal strain. Under these circumstances it is necessary to use either the oxide or the hydrate. It is sometimes desirable to use the carbonates in wares burned at lower temperatures in order to obtain a porous body.[3]

Since the quantity of carbonate used is generally small and the chemical composition of the mixture may vary slightly, it follows that the impurities generally found in limestones are entirely negligible.

In glazes, magnesium oxide tends to absorb SO_3 from the kiln gases with production of a scum appearance. Although this can be overcome by skillful firing, it makes a low magnesia content desirable in most glazes.

WATER SOFTENING.

"Temporary hardness" of water is caused by the presence of calcium carbonate. This substance is practically insoluble in pure water, but is held in solution by the presence of carbon dioxide, which is found in practically all natural water. If this carbon dioxide is removed, the calcium carbonate will be thrown out of solution. The carbonic acid may be removed by boiling, but it is cheaper to neutralize it with lime. The lime reacts with the carbon dioxide to form calcium carbonate and, since the carbon dioxide is thus removed, this calcium carbonate, together with that originally present in the water, will be removed by the same process, the magnesium oxide in the lime will take no part in the reaction and must be considered as an impurity.

According to the usual method of procedure the lime is slaked to a cream, which is fed in an automatically regulated stream into the main body of water. Experience has shown that a well-burned, high-calcium lime will produce the greatest quantity of cream, which is also of better quality, because the lime stays in suspension longer and can be more thoroughly disseminated throughout the main body of water.

SODA ASH AND CAUSTIC SODA.

Most of the soda ash sold in this country is made by the "ammonia-soda" process. A solution of common salt is saturated with ammonia, and the mixture is treated with carbon dioxide. When the resultant solution is evaporated the soda ash is obtained by crystallization. Ammonia is expensive, and consequently the gas must be recovered and used over again. For this purpose the mother liquor is treated with lime and distilled. The lime replaces the ammonia in its compounds, and thus the gas is set free to distill off.

[1] Hope, Herford, Comparative effects of CaO, MgO, BaO, SrO, and ZnO on some china bodies: Am. Ceramic Soc. Trans., vol. 11, p. 494, 1909.
[2] Ashley, H. E., The requirements of pottery materials: Am. Ceramic Soc. Trans., vol. 12, p. 445, 1910.
[3] Bourry, Emille, Treatise on ceramic industries, p. 79, 1901.

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It is evident that this industry demands limestone, for both the lime and the carbon dioxide are used. The impurities in the stone are not harmful. It would seem that magnesium oxide should be as effective as calcium oxide in breaking up the compounds of ammonia, yet Lunge makes the statement that "magnesium limestone is not suitable for this industry." [1]

Caustic soda is made by dissolving soda ash in water and adding lime. Insoluble calcium carbonate is precipitated, and caustic soda is left in solution. In this reaction the magnesia is entirely inert.[2] The impurities are undesirable because they form a gelatinous precipitate which does not settle clear, and therefore leads to a contamination of the finished product. In this industry quicklime is preferable to hydrated lime because it hastens the reaction.

BLEACHING POWDER.

Bleaching powder is an oxychloride of calcium which is formed by the action of chlorine gas on moist slaked lime. The resultant product is sold on the basis of available chlorine. Any impurities in the lime will lower the quantity of chlorine absorbed, and consequently the value of the product. Magnesia is especially objectionable because it forms magnesium chloride.[3] This substance absorbs water from the air and makes the powder sticky and hard to handle.

Hydrated lime is better suited for this industry than quicklime, because it contains fewer impurities, is easier to handle, and requires no preparation before using.

CALCIUM CARBIDE.

This substance, the source of acetylene, is made by heating a mixture of lime and coke in an electric furnace. For this purpose the only useful ingredient of the lime is calcium oxide.[4] Magnesia and other impurities are objectionable because the whole charge must be fused, and electric power is too expensive to waste it by heating useless material. For the same reason, quicklime is preferable to either hydrated lime or limestone.

ILLUMINATING GAS AND AMMONIA.

When illuminating gas is made by the distillation of coal, the crude product contains, among other compounds, carbon dioxide, hydrogen sulphide, and hydrocyanic acid. All of these would be objectionable to the consumer. Their removal may be effected by passing the gas through layers of moist slaked lime. For this purpose calcium oxide only is useful, although the magnesia and impurities are not harmful.[5] Hydrated lime is to be preferred to quicklime, because it is easier to handle and requires no preparation.

Crude coal gas is the chief source of ammonia. This is removed by washing the gas with water before it has reached the lime purifiers. The solution thus obtained carries both free ammonia gas and some compounds of ammonia. The free gas is driven off by heat and col-

[1] Lunge, George, Manufacture of sulphuric acid and alkali, 2d ed., vol. 3, p. 37, 1891–1896.
[2] Idem, vol. 2, p. 799.
[3] Idem, vol. 3, p. 440.
[4] Thompson, G. F., Acetylene gas and calcium carbide, p. 47, 1898.
[5] Hunt, Charles, Gas lighting, p. 136, 1900.

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lected. Lime is then added to break up the compounds and the ammonia thus liberated is also distilled and collected.

Calcium and magnesium oxides should act with equal facility in liberating the ammonia, but, according to Lunge, magnesium limestone is not applicable to this industry. The impurities are not harmful. Either quick or hydrated lime may be used, with little advantage in favor of either.

CALCIUM CYANAMIDE AND CALCIUM NITRATE.

These substances, known technically as "lime-nitrogen" and "nitrate-lime" have recently been put on the market as commercial fertilizers. They represent means of converting the nitrogen of the air into plant food.

Calcium cyanamide is prepared by heating a mixture of lime and coke in an electric arc furnace, and treating the fused mass with nitrogen. The nitrogen is obtained from the fractional distillation of liquid air. Pure, high-calcium quicklime is required for this industry.[1] Any impurities are undesirable on account of the expense required to heat them.

If air is passed through an electric arc, the nitrogen and oxygen contained in it will combine. The oxide of nitrogen thus formed, when dissolved in water, produces nitric acid. This will combine with any base to form the corresponding nitrate. Since lime is the cheapest of all bases, and has a fertilizing value of its own, it is obviously the base to use. Hence calcium nitrate is formed. Magnesia acts in a similar manner, and its use is dependent on whether or not it would be harmful as a fertilizer. The presence of impurities in the lime is a matter of indifference, and quicklime, hydrated lime, or limestone will produce identical results. Hydrated lime is probably the most economical.

SPRAYING.

Lime enters into the preparation of a number of insecticides used in spraying vegetation. For such purpose calcium oxide is the only useful constituent of the lime. Magnesia and impurities are not harmful. The physical quality of the lime is of paramount importance. The material is sprayed on the vegetation through some form of atomizer, and therefore must contain no coarse particles or grit. For this reason hydrated lime screened to pass 150 or 200 mesh (a commercial article) would certainly give better satisfaction than lump lime.

SUGAR.

In the manufacture of sugar, both carbon dioxide and lime are used. Therefore, sugar manufacturers prefer to buy limestone and burn their own lime.

The juice extracted from either sugar beet or sugar cane contains various impurities. Some of these could discolor the sugar, and others (organic acids) would invert it, that is, they would change the sugar into uncrystallizable glucose, and thus reduce the yield. In order to remove these impurities the juice is heated almost to boiling in the presence of an excess of lime. This lime combines with the

[1] Kershaw, J. B. C., Calcium cyanamide: The Electrician, vol. 60, p. 548, 1907-1908.

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acids, breaks up the other organic compounds, and forms insoluble salts. But it also forms an insoluble compound with the sugar itself. For this reason after the lime has completed its action, carbon dioxide is forced into the liquid. This breaks up the combination between the lime and the sugar, and throws down all the lime as calcium carbonate. This precipitate carries with it all suspended matter, leaving a clear solution of sugar.

For these purposes calcium oxide only is useful. Impurities are apt to cause trouble. Thus, magnesium carbonate is more soluble in sugar solutions than calcium carbonate, and the salt so dissolved is later deposited on the tubes in the evaporating pans, thus making it necessary to clean them more frequently. Any silica present is thrown down as a gelatinous precipitate. This becomes a general nuisance by coating the cloth in the filter presses.[1]

DISTILLATION OF WOOD.

The destructive distillation of wood gives rise to four products: Gas, pyroligneous acid, tar, and charcoal. Of these pyroligneous acid is of most interest to the lime manufacturer. From this solution are prepared wood alcohol, acetic acid, and acetone, and lime is an essential ingredient in the manufacture of all these. First, the crude acid is treated with an excess of lime and distilled. Wood alcohol passes over, but acetic acid is held in the still in chemical combination with the lime. This mixture is known as "gray acetate of lime." Acetone may be produced from it simply by dry distillation; or it may be treated with sulphuric acid and the acetic acid distilled off. The wood alcohol is again treated with lime and redistilled in order to purify it.

For any of these purposes calcium oxide is the only useful constituent of the lime.[2] Magnesia and impurities are not harmful. Hydrated lime may be used instead of quicklime for any of these purposes, except the final distillation of the wood alcohol. For other purposes probably neither substance has any advantage over the other.

PAPER.

Wood pulp for the manufacture of paper is prepared by one of three processes—mechanical, soda, and sulphite, of which only the second and third interest the lime manufacturer.

In the soda process lime is used to causticize sodium carbonate, thus recovering the caustic soda used in cooking the wood.

Calcium oxide is the only constituent of the lime useful in the soda-pulp industry. The magnesia and the impurities are not harmful. Hydrated lime may be used instead of lump lime, but the latter is to be preferred, since the heat generated by its slaking hastens the reaction with the soda.

Another solution which may be used in place of caustic soda for dissolving the cementing constituents of wood is "bisulphite liquor." This is a mixture of calcium amd magnesium bisulphites held in solution by an excess of sulphur dioxide. The liquor is prepared by one of two methods: Limestone may be subjected to the solvent

[1] Manufacture of sugar: Internat. Lib. of Technology, sec. 50, p. 36, Internat. Textbook Co., Scranton, Pa., 1902.

[2] Dumesny, P., and Moyer, J., Wood products, distillates, and extracts, p. 8.

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action of sulphur dioxide and water, or milk of lime may be treated with sulphur dioxide; the resultant solution is the same in either case.

For the maker of sulphite pulp magnesia is a desirable constituent of the lime or limestone. Magnesium sulphite is more soluble than calcium sulphite (100 parts of water dissolving 1.25 parts of the former or 0.0043 parts of the latter), and consequently permits of making a stronger liquor. Moreover, the presence of magnesia in the liquor gives the pulp a better color and makes it softer to the touch, so that it will felt together better when made into paper. Therefore, magnesian lime is much preferable to the high-calcium lime. The impurities are not harmful.

If limestone is used, it should be as porous as possible to permit a rapid solution.

Hydrated lime is preferable to lump lime, because it is easier to handle and contains fewer impurities.

PAINTS.

Ground lime, air-slaked lime, levigated chalk (natural whiting), and chemically precipitated calcium carbonate are used to a large extent in the paint and allied industries. For these purposes fineness of grain is essential; sometimes the color or chemical composition is of equal importance. It is difficult to obtain a limestone of sufficient whiteness or to grind it sufficiently fine to meet the requirements. It is therefore an advantage to use air-slaked lime or hydrated lime.

Cold-water paints consist essentially of hydrated lime, pigments, and casein ground together. From the nature of the substances it is obviously impossible to use quicklime, and magnesian hydrates are probably to be preferred over high-calcium hydrates on account of their better spreading qualities.

GLYCERIN, LUBRICANTS, AND CANDLES.

Most common fats are compounds of glycerin with various organic acids. These compounds can be broken up by heating the fat with lime and water under pressure. The glycerin is liberated, and the lime takes its place in the compounds. Practically all of the glycerin used in this country (mostly in the manufacture of explosives) is made in this way. The lime "soaps" formed by this process are sometimes mixed with heavy mineral oils and sold as lubricants or greases. They are of especial value for the lubrication of heavy machinery or for use at high temperatures. The soaps may be treated with sulphuric acid; the separated fatty acids are recovered and used in the manufacture of soap and allied products.

Calcium oxide is the only useful constituent of the lime, although the magnesia and impurities are not harmful.[1] Quicklime is probably preferable to hydrated lime, because the heat of slaking can be used.

TANNING.

In the leather industry lime is used in the "depilation" process. The hair is so loosened from the hide by soaking it in lime water that it can be removed by subsequent scraping. In regard to the quality of lime to be used the following statement is made:

> The presence of magnesia and clay is injurious, not only by diminishing the amount of lime present, but by making the lime much more difficult to slake; and iron oxides,

[1] Sadtler, S. P., Industrial organic chemistry, p. 58, Lippincott, 1906.

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though quite insoluble, may become mechanically fixed in the grain of the hide, and may be the cause of subsequent stains.[1]

The use of hydrated lime would remove the above objections to magnesia, but not those to iron. Hydrated lime is probably preferable to quicklime for this reason, as well as for the fact that it is easier to handle.

For some particular grades of leather, such as morocco, the presence of magnesia has been found to be advantageous.

OTHER USES.

In addition to the uses outlined, limestone, quicklime, and hydrated lime play a part of more or less importance in a large number of industries, among which may be mentioned the following:[2]

The manufacture of dichromates, magnesia, bone ash, glue, and varnish; as a refining and purifying agent in the distillation of mercury, in the clarification of grain, in refining fats, greases, butter, linseed oil, and petroleum, in preserving eggs, and as a general disinfecting and deodorizing agent; as a filler in the paper, textile, linoleum, and rubber industries; as a mordant in dyeing; as an abrasive in polishing; in the manufacture of calcium-light pencils, and of magnesium for flashlight powders; as limewater in medicine; for the recovery of potassium cyanide used in extracting gold and silver from their ores; to neutralize the sulphuric acid used in pickling steel; and in a large number of other industries.

The following table summarizes the more important of the chemical uses of lime, together with the kind of lime most suitable to such purposes:

Chemical uses of lime.

- Agricultural industry:
  - As a soil amendment, c, m.[3]
  - As an insecticide, c, m.
  - As a fungicide, c, m.
- Bleaching industry:
  - Manufacture of bleaching powder, "Chloride of lime," c.
  - Bleaching and renovating of rags, jute, ramie, and various paper stocks, c, m.
- Caustic alkali industry:
  - Manufacture of soda, potash, and ammonia, c.
- Chemical industries:
  - Manufacture of ammonia, c.
  - Manufacture of calcium carbide, calcium cyanimid, and calcium nitrate, c.
  - Manufacture of potassium dichromate and sodium dichromate, c.
  - Manufacture of fertilizers, c, m.
  - Manufacture of magnesia, m.
  - Manufacture of acetate of lime, c.
  - Manufacture of wood alcohol, c.
  - Manufacture of bone ash, c, m.
  - Manufacture of calcium carbides, c.
- Chemical industries—Continued.
  - Manufacture of calcium-light pencils, c.
  - In refining mercury, c.
  - In dehydrating alcohol, c.
  - In distillation of wood, c.
- Gas manufacture:
  - Purification of coal gas and water gas, c, m.
- Glass manufacture:
  - Most varieties of glass and glazes, c.
- Milling industry:
  - Clarifying grain, c, m.
- Miscellaneous manufactures:
  - Rubber, c, m.
  - Glue, c, m,
  - Pottery and porcelain, c, m.
  - Dyeing fabrics, c, m.
  - Polishing material, c, m.
- Oil, fat, and soap manufacture:
  - Manufacture of soap, c.
  - Manufacture of glycerine, c.
  - Manufacture of candles, c.
  - Renovating fats, greases, tallow, butter, c, m.

[1] Proctor, H. R., Principles of leather manufacture, p. 121, Spon & Chamberlain, New York, 1903.
[2] Burchard, E. F., Production of lime in 1911: U. S. Geol. Survey Mineral Resources, 1911, pp. 645-718, 1912.
[3] High-calcium lime is indicated by "c," magnesian and dolomitic lime by "m."

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Oil, fat, and soap manufacture—Contd.
Removing the acidity of oils and petroleum, c, m.
Lubricating greases, c, m.
Paint and varnish manufacture:
Cold-water paint, c, m.
Refining linseed oil, c, m.
Manufacture of linoleum, c, m.
Manufacture of varnish, c, m.
Paper industry:
Soda method, c.
Sulphite method, m.
For strawboard, c, m.
As a filler, c, m.
Preserving industry:
Preserving eggs, c.
Sanitation:
As a disinfectant and deodorizer, c.
Purification of water for cities, c.
Purification of sewage, c.
Smelting industry:
Reduction of iron ores, c, m.
Sugar manufacture:
Beet root, c.
Molasses, c.
Tanning industry:
Tanning cowhides, c.
Tanning goat and kid hides, c, m.
Water softening and purifying, c.

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INDEX.

A.

Page.

Abrasive materials, by Frank J. Katz..... 253–272
artificial..... 268, 272
imports..... 256, 259, 269–261; 269, 271
list of States producing..... 254
value, total..... 253
by kinds..... 255
Accidents, coal mining..... 716
Africa, asbestos..... 340
diamond..... 667–668
magnesite..... 450
mica..... 2
petroleum..... 1118–1121
exports to..... 1082–1084
phosphate rock..... 280–288
talc..... 154
Alabama, barytes..... 169
brick and tile..... 547, 558
cement, Portland..... 121–122, 126
puzzolan..... 143
clay..... 618
clay products..... 547, 558, 583
coal..... 720, 726, 809–813
coke..... 461, 491
diamond..... 663
fuller's earth..... 109
furnace flux..... 1327
glass sand..... 327, 330
granite..... 1290, 1296, 1300
graphite..... 188, 190–195
lime..... 312, 314, 317, 1533
limestone..... 1290, 1319, 1322–1323, 1533
marble..... 1290, 1314, 1533–1534, 1537
mica..... 2, 6
millstones..... 255–256, 258
mineral waters..... 394, 398, 402
natural gas..... 1412–1420, 1430–1431
acreage..... 1421
ocher..... 51
pottery..... 547, 573, 577
sand and gravel..... 327–328, 330–331
sandstone..... 1290, 1329, 1332–1333
Alaska, barytes..... 172
coal..... 720, 726, 813–815
graphite..... 195–196
gypsum..... 356, 360, 363–364
jade..... 671
marble..... 1290, 1314
petroleum, exports to..... 935, 1080, 1420
Algeria, gypsum..... 360
phosphate rock..... 279, 286–288
Alizarin and colors or dyes, imports..... 491
Allegheny Mountain, Pennsylvania, coke district..... 508
Allegheny Valley, Pennsylvania, coke district..... 508
Alundum (artificial corundum), production.. 272

Page.

Alunite..... 90–92
analysis..... 90
Analyses, alunite..... 90
asbestos..... 346
fluorspar..... 377, 381
graphite..... 201, 213, 215
limestones..... 1350–1351, 1381–1394, 1558
mineral waters..... 433–434
natural gas..... 1468–1473, 1487
petroleum..... 1126–1279
potash salts..... 90
pyrite..... 41
salts in sea water..... 1513
slate..... 88, 1348
sulphur..... 32
talc..... 158
Anhydrite salts, imports..... 491
Anthracite coal, colliery consumption..... 720
(*See also* Coal.)
Colorado..... 747
distribution..... 720
exports..... 780
imports..... 780
initial railroads..... 896
New Mexico..... 747
Pennsylvania..... 883–896
fields..... 896
prices..... 886–887
production..... 711, 720, 883–896
shipments..... 889
by regions..... 894–895
value..... 711, 720, 883
Apatite, imports..... 277
deposits..... 285–286
Appalachian States, coal field..... 736
oil field..... 944–946, 949, 970–1003
Architectural terra cotta..... 549, 551, 559
Argentina, mica..... 2
petroleum..... 1101
exports to..... 1083
talc..... 154, 156
Arizona, alunite..... 91
asbestos..... 339, 342–347
basalt..... 1339
brick and tile..... 547, 558
cement, Portland..... 121, 126
clay products..... 547, 558
fluorspar..... 375
fuller's earth..... 112
furnace flux..... 1327
granite..... 1290, 1298, 1300, 1338
gypsum..... 356, 364
lazulite..... 675
lime..... 312, 314, 317, 1344
limestone..... 1290, 1319, 1322–1323, 1344
marble..... 1290, 1314, 1342
mica..... 2

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Page.

Arizona, onyx marble ... 1343
potash ... 91
quarts ... 177–178
rhyolite ... 1340–1342
sand and gravel ... 327–328, 330–331
sandstone ... 1290, 1329, 1331, 1344
slate ... 77, 1342
tuff ... 1340
turquoise ... 693, 694
volcanic rocks ... 1339–1342
Arkansas, brick and tile ... 547, 558
clay products ... 547, 558
coal ... 720, 726, 815–818
diamond ... 663–665
fuller's earth ... 109, 111–112
granite ... 1290, 1298, 1300
graphite ... 196
gypsum ... 364
jasper ... 671
lime ... 312, 317, 1546
limestone ... 1290, 1319, 1321, 1545–1546
marble ... 1545–1546
mineral waters ... 394, 398, 403
natural gas ... 1412–1420, 1452
acreage ... 1421
oilstones (novaculite) ... 259–260
petroleum ... 962, 1078
phosphate rock ... 285
pottery ... 547, 573, 577
quarts (gem) ... 681
sand and gravel ... 327–328, 330–331
sandstone ... 1290, 1329, 1332–1333
slate ... 75–77
tripoli ... 267
Aruba, phosphate rock ... 279
Asbestos, by J. S. Diller ... 339–354
analysis of chrysotile asbestos ... 346
deposits in United States, by States ... 342–349
Arizona ... 342–347
chrysotile of Grand Canyon ... 342–344
chrysotile of Ash Creek ... 345–346
composition of Arizona chrysotile ... 346
California ... 347–348
Georgia ... 348–349
Vermont ... 349
Wyoming ... 349
foreign countries ... 351–353
Canada ... 351–352
Russia ... 352–353
generalized section of asbestos belt ... 345
imports ... 340–341
map showing asbestos in Arizona ... 342
nodule of serpentine ... 346
prices ... 339–340
production ... 339
prospecting for asbestos ... 350–351
quarrying and mining ... 349–350
recent investigations ... 353–354
section of east slope of Ash Creek ... 345
thermal resistivity ... 353
world's production ... 340
Asiatic Russia, coal ... 783
Asphalt, related bitumens, and bituminous rock, by David T. Day ... 537–544

Page.

Asphalt, exports ... 542–543
from Trinidad ... 543
imports ... 541–542
ozokerite imports ... 541
production ... 537–541
manufactured or oil ... 538
natural ... 537
by varieties and by States ... 538
conditions, by States ... 539–540
in principal countries ... 540–541
tariff ... 542
Asteria quartz ... 704
Australia, asbestos ... 340
coal, imports from ... 779
gypsum ... 360
magnesite ... 450
mica ... 2
petroleum ... 1113
phosphate rock ... 279
pyrite ... 37
Austria-Hungary, asbestos ... 341
asphalt ... 541
coal ... 783–784
graphite ... 189
magnesite ... 443–444, 448, 450
petroleum ... 1107–1109
talc ... 156

B.

Ball clay, production by States ... 615–618
Baltimore, Md., coal-trade review ... 795–798
Barytes, by James M. Hill ... 165–174
barium compounds ... 167
bibliography ... 172–173
Canada ... 167
character ... 168
imports ... 166–167
map of eastern United States showing barytes localities ... 170
occurrence ... 169–172
prices ... 166
production, by States ... 165–166
uses ... 168
Bastin, Edson S., paper on graphite ... 181–251
Bedford oolitic limestone ... 1324
Belgium, asbestos ... 341
asphalt ... 542
coal ... 783–784
feldspar ... 151
flint pebbles ... 179
magnesite ... 444
ocher ... 55
petroleum, exports to ... 1082–1084
phosphate rock ... 279
pyrite ... 37
talc ... 156
Bituminous coal ... 709–925
(*See also* Coal.)
Bituminous rock ... 538
(*See also* Asphalt and bituminous rock.)
Bluestone, production, by States ... 1334
(*See also* Stone.)
by uses ... 1334
Bolivia, petroleum ... 1089

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Page.

Bone dust, imports ... 277
Bone china, delft, and bellesk ware, production ... 570–573
Borax, by Charles G. Yale and H. S. Gale ... 521–536
bibliography ... 523
development of industry ... 523
general conditions ... 521
distribution of deposits, map of ... 522
imports ... 522
prices ... 522
production ... 521
tariff ... 522
Borneo, coal ... 783
petroleum ... 1114
Bosnia, coal ... 783
pyrite ... 37
Boston, Mass., coal-trade review ... 793–795
Brazil, coal ... 783
mica ... 2
petroleum, exports to ... 1083
Brick clay, production, by States ... 618
Brick and tile ... 547, 554–568
architectural terra cotta ... 549, 551, 559
common ... 549, 551, 558
Hudson River district ... 565–568
drain tile ... 549, 551, 559
enameled brick ... 549, 551, 559
exports ... 582
fancy or ornamental, value ... 549, 551, 559
fire, quantity and value ... 549, 551, 560
fireproofing ... 549, 551, 559
front, quantity and value ... 549, 551, 559
imports ... 581
prices, by States and kinds ... 551, 558–560
products, by States ... 558–560
quantity and value ... 583–614
rank of producing States ... 558
sewer pipe ... 549, 551, 559
stove lining ... 549, 551, 560
tile, not drain ... 549, 551, 560
vitrified paving, quantity and value ... 549, 551, 558
British Africa, petroleum exports to ... 1084
British Australasia, petroleum exports to ... 1084
British Columbia, coal, imports from ... 779
magnesite ... 449
British East Indies, magnesite ... 444
petroleum ... 1113
exports to ... 1084
British North America, petroleum ... 1083, 1091–1094
British West Indies, asphalt ... 542
petroleum, exports to ... 1083
Broadtop, Pennsylvania, coke district ... 508
Bromine, by W. C. Phalen (*see also* Salt, bromine, and calcium chloride) ... 307
production ... 307
Bryan Heights, sulphur ... 25–27
Buffalo, N. Y., coal-trade review ... 802–803
Building operations, by cities ... 621–635
Building sand, production ... 327–331, 333
Bulgaria, coal ... 783
Burchard, Ernest F., paper on cement ... 117–143
fluorspar and cryolite ... 373–381
lime, source of ... 1511–1555
stone ... 1285–1410
Bureau of soils, study of kelps of Pacific coast ... 93–94
Burrstones and millstones, imports ... 256

C.

Page.

Caddo, Louisiana, natural gas ... 1446
petroleum ... 1055–1061
Calcium chloride (*see also* Salt, bromine, and calcium chloride) ... 307
production ... 307
Calcium cyanamid, imports ... 277
California, agate ... 650–652
asbestos ... 347–348
asphalt ... 539
barytes ... 172
borax ... 521
brick and tile ... 547, 558, 584
cement, Portland ... 121–122, 126
clay ... 618
clay products ... 547, 558, 584
coal ... 720, 726, 818–820
diamond ... 665
diatomaceous earth ... 180, 268, 270–271
feldspar ... 148–149
fuller's earth ... 109, 111–112
furnace flux ... 1327
gasoline from natural gas ... 1480, 1484–1485
glass sand ... 327, 330
granite ... 1290, 1298, 1300, 1354–1357
graphite ... 188, 196
gypsum ... 356, 360, 365
jasper ... 671–674
kelp ... 92–96
kunzite ... 682
lapis lazuli ... 674
lime ... 312, 314, 317
limestone ... 1290, 1319, 1322–1323, 1362–1363
magnesite ... 441
marble ... 1290, 1314, 1360–1362
metallic paint ... 56
mica ... 2
mineral waters ... 394, 398, 404
natural gas ... 1412–1420, 1450–1452
acreage ... 1421
gasoline from ... 1480
oil field ... 945, 948, 949, 1062–1070
ocher ... 51
opal ... 675–676
petroleum ... 935–938, 945, 948, 949, 962, 1062–1070
potash ... 87–89
pottery ... 547, 573, 577
pumice ... 271
pyrite ... 34, 37
quartz ... 177–178
salt ... 293–294, 296–297
sand and gravel ... 327–328, 330–331
sand-lime brick ... 18–19, 20
sandstone ... 1290, 1329, 1332–1333, 1363–1364
sienna ... 53–54
slate ... 75, 78, 1359
soapstone ... 1362
spodumene ... 681
sunstone ... 670
talc ... 153, 155, 157–160
tourmaline ... 688
trap rock ... 1290, 1312
turquoise ... 694–697
volcanic rocks ... 1357–1359
Canada, asbestos ... 340–341, 351–352
asphalt ... 542
barytes ... 167

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Page.

Canada, cement 140-141
coal 783
exports to 779
corundum 261
feldspar 151
flint pebbles 179
fluorspar 381
graphite 189
grindstones 250
gypsum 360
magnesite 444, 449
mica 2, 9
natural gas 1455-1456
ocher 53, 55
petroleum 1091-1094
exports to 1062
phosphate rock 279
pyrite 37
quartz 179
sulphur 24
talc 154, 156
Cape Colony, asbestos 340
coal 783
diamond 667
Carat, metric 705
Carbon, black 1488-1490
(*See also* Natural gas.)
Carborundum, production 272
C. C. ware 570, 573
Cement industry, by Ernest F. Burchard .. 117-143
Canada 140-141
comparison of production of Portland and natural 128
exports 140
imports 139-140
magnesia cement 450-453
natural 141-142
industry, 1818-1913 142
production, by States 141
Portland 119-139
condition of industry 131-139
business conditions 131
depreciation of plants 132-133
manufacturing conditions 133-134
new Portland cement plants 135
consumption 126-127
growth of industry 127-129
investigations of cement and concrete .. 135-139
action of alkali and sea water 135-137
concrete roads 139
microscopic analyses 137
blended or sand cements 137-139
production and shipments 119-125
by districts 121-122
by raw materials 124-125
by States 120-121
Lehigh district 123
range in price 129-131
stocks 125-126
puzzolan 142-143
production by States 143
total production 118-119
value 119
Central America, coal exports to 779
petroleum, exports to 1083, 1097-1098
Ceylon, graphite 189, 234-238

Page.

Ceylon, magnesite 450
mica 2
Chile, coal 783
petroleum, exports to 1082, 1101-1102
China and porcelain, exports 582
imports 581
product, value 576, 573
China, coal 783
graphite 189
mica 2
petroleum 1115
exports to 1084
Chosen (Korea), coal 783
graphite 189, 236-239
Christmas Island, phosphate rock 279
Cincinnati, Ohio, coal-trade review 803-804
Cities, list of, supplied with natural gas .. 1499-1507
Clay, imports 630
mined, by States 613
varieties 615
price 615
value 615, 618
Clay, notes on occurrence and use of flint, by J. H. Hance 639-648
analyses 639
bibliography 645
development 642
history 640
introduction 639
occurrence 640
sampling and testing 642
uses 640
Clay products, exports 582
imports 581
in various States 603-614
rank of States in value 553
value, with increase or decrease 547-548
by States 548
by varieties 549, 551
Clay-working industries, by Jefferson Middleton 545-648
bibliography 635
building operations 621-635
production 547
increase and decrease 548-549
value 547-551
Clearfield Center, Pa., coke district 806
Cleveland, Ohio, coal-trade review 804-805
Coal, by Edward W. Parker 709-928
accidents, mining 716
acknowledgments 710
anthracite 711, 883-896
average tonnage per man 753
Colorado 747
exports 780
imports 780
initial railroads 896
New Mexico 747
Pennsylvania production 711, 883-896
prices 896-897
bibliography 926-928
classification of, by States 747-749
consumption 717
colliery 720
in manufacture of coke 720
Cumberland 863

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	Page.
Coal, days active	730, 751
exports	779–780
fields, division into provinces	730–735
areas	733–734
general statement	709
hours to working day	755
imports	779–780
labor statistics by States	750–757
troubles	757–759
machine-mined, by States	762–765
machines, number and kinds	763
made into coke	720
mining methods	765–769
number of employees	720, 751
prices	769–770
average price	720
production	711, 718–767
anthracite and bituminous	711, 720
average annual, per man	758
by classes of mines	738–746
by decades	728
by different methods	767
by fields	735
by five-year periods	735
by geographic divisions	733
by kinds	747–749
by machines	759–765
by States	720
distribution	720
from earliest times, by States	727–732
increase and decrease in 1913	726
provinces, six, and regions	730–736
rank among coal-producing countries	781
of producing States	736–738
relative importance of various fields	736
percentage of total production	736
shipments by railroads	771–779
shot off the solid	767
sold to local trade	720
statistics of labor	750–757
men employed	751
mining machines	763
strikes	757–759
days lost	758–759
number of men	758–759
summary of statistics	711–718
tariffs	780–781
trade review	784–809
unit of measurement	710
used at mines	720
value	711, 720
per ton	769–770
washed at mines	768–769
world's production	781–784
United States, percentage of	783
yearly production, 1856–1913	722
Coal-tar products, imports	490–491
Coke, by Edward W. Parker	455–520
by-product, manufacture	478–489
list of by-product plants	486
production, compared with beehive coke	480
statistics of	484
value of products	483
coal used in making	471
condition of coal charged into ovens	475
Coke, Connellsville, Pa., district	508, 512
prices	512
shipments	511
exports	490
imports	490
coal-tar products	490
number of establishments	468
ovens	469
ovens built and building	470
prices	458, 512
production	457–489
by districts, Pennsylvania	507
West Virginia	518
by States	461, 491–520
in previous years	461
increase and decrease	464
quantity and value of coal used	472
rank of States in production	471
statistics of, in 1913	457
value at ovens	464
yield of coal in coke	474
Collos cement	142–143
Colombia, asphalt	542
petroleum	1098
Colorado, agate	652
amazon stone	668
brick and tile	547, 558
cement, Portland	121–122, 126
clay	618
clay products	547, 558, 585
coal	720, 726, 820–824
anthracite	749
coke	461, 493
feldspar	149
fluorspar	875, 880
fuller's earth	109, 111–112
furnace flux	1327
gasoline from natural gas	1480, 1486
granite	1290, 1298, 1300
graphite	188, 197–198
grindstones	258
gypsum	356, 360, 364
lime	312, 314, 317, 1551
limestone	1280, 1319, 1321, 1550–1551
marble	1290, 1314, 1551
mica	2, 6
mineral waters	394, 398, 405
natural gas	1412–1420, 1453
acreage	1421
gasoline from	1480
petroleum	935–938, 945, 948, 949, 962, 1071–1074
potash	91
pottery	547, 573, 577
rhodonite	681
sand and gravel	327–328, 330–331
sand-lime brick	18–19, 20
sandstone	1290, 1329, 1332–1333
slate	78
Connecticut, beryl	656
brick and tile	547, 558
clay products	547, 558, 586
diatomaceous earth	180, 268
feldspar	148–149
furnace flux	1327
granite	1290, 1300
lime	312, 314, 317, 1530

Digitized by Google

Page.

Connecticut, limestone..... 1290, 1319, 1322, 1530
marble..... 1531
mica..... 2
mineral waters..... 394, 398, 406
pottery..... 547, 573, 577
quartz..... 177–178
sand and gravel..... 327–328, 330–331
sand-lime brick..... 18
sandstone..... 1290, 1329, 1333
trap rock..... 1290, 1312
Connellsville, Pa., coke..... 508–512
average prices..... 512
shipments..... 511
Coons, A. T., paper on slate..... 71–84
Corundum and emery..... 260–261
Canada..... 261
imports..... 261
production..... 260–261
Cream white (C. C.) ware, product..... 570–573
Crushed steel..... 272
Crushed stone, by States and uses.. 1291, 1292–1295
Cryolite..... 381
imports and prices..... 381
(*See also* Fluorspar and cryolite.)
Cuba, asphalt..... 542
petroleum, exports to..... 1082
Cumberland coal..... 853
Curaçao, phosphate rock..... 279
Cyprus, asbestos..... 340
gypsum..... 360
umber..... 55

D.

Danish West Indies, asphalt..... 542
Davis, Charles A., paper on peat..... 383–392
Day, David T., paper on petroleum..... 929–1294
asphalt..... 537–544
De Golyer, E., production of petroleum in Mexico in 1913..... 1095
Delaware, brick and tile..... 547, 558
clay..... 618
clay products..... 547, 558
granite..... 1290, 1300
lime..... 1533
limestone..... 1532
mineral waters..... 394, 398, 407
sand and gravel..... 327–328, 330–331
Delft ware..... 570, 573
Denmark, flint pebbles, imports..... 179
petroleum, exports to..... 1083
Diamond..... 663–668
Africa..... 667–668
Alabama..... 663
Arkansas..... 663–665
California..... 665
Idaho..... 665
Indiana..... 665
imports..... 708
New York..... 666
Virginia..... 666
Diatomaceous earth..... 180, 267–271
(*See also* Abrasives *and* Silica.)
imports..... 269
notes on..... 269–271
production..... 268

Page.

Diller, J. S., paper on asbestos..... 339–354
talc and soapstone..... 153–163
District of Columbia, brick and tile..... 547, 558
clay products..... 547, 558
granite..... 1290, 1298
mineral waters..... 394, 398, 407
pottery..... 547, 573, 577
sand and gravel..... 330–331
sand-lime brick..... 18–19, 20
Dole, R. B., paper on mineral waters..... 393–434
on radioactivity of mineral waters..... 435–440
Draintile, value..... 549, 551, 559
Dutch East Indies, coal..... 783
petroleum..... 1114
exports to..... 1084
Dutch West Indies, phosphate rock..... 279

E.

Earthenware and stoneware, exports..... 582
imports..... 561
red, production..... 570, 573
Eastern coal field, production..... 783
Ecuador, petroleum..... 1096
Egypt, petroleum..... 1118
Electrical supplies, porcelain..... 570, 574
Emery (*see also* Corundum and emery)..... 260–261
Canadian corundum..... 261
imports..... 261
production..... 260–261
Emley, W. E., manufacture and use of lime..... 1556–1593
Enameled brick..... 549, 551, 559
Engine sand, production..... 327–331, 333
England, asbestos..... 341
Exports, asphalt..... 542
brick..... 582
cement..... 140
clay products..... 582
coal..... 779–780
coke..... 490
earthen and stone ware..... 582
gasoline..... 1486
lime..... 315
marble..... 1295
mineral waters..... 402
petroleum..... 1080–1090
phosphate rock..... 278–279
pottery..... 582
salt..... 295–296
slate..... 77
stone..... 1295
sulphur..... 25

F.

Fancy or ornamental brick..... 549, 551, 559
Feldspar, by Frank J. Kats..... 145–151
composition, occurrence, and uses..... 145–146
gems..... 668–670
industry, by States..... 149–151
prices..... 147
production, by States..... 147–148
increase or decrease..... 148
in other countries..... 151
review of trade..... 145
Fertilizers of all kinds, imported..... 102–106

Digitized by Google

Page.

Fire brick 549, 551, 560
Fire clay, production, by States 618
Fireproofing, value 549, 551, 559
Fire sand, production 327–331, 333
Flat Top, W. Va., coke district 519
Flint clay, occurrence and use of 639–648
Flint pebbles, imports 179
(*See also* Silica.)
Florida, brick and tile 547, 558
clay 618
clay products 547, 558
diatomaceous earth 180, 268
fuller's earth 109, 111–112
gypsum 365
lime 312, 314, 317, 1533
limestone 1290, 1319, 1323, 1533
marble 1533–1534
mineral waters 394, 398, 407
phosphate rock 273–275, 280–282
sand and gravel 327–328, 330–331
sand-lime brick 18–19, 20
sandstone 1290, 1329, 1333
Fluorspar and cryolite, by Ernest F. Burchard 373–381
analyses 377, 381
Canada 381
composition 376–377
consumption 380
curve of production of fluorspar 1883–1913. 376
Great Britain 381
imports 379
prices 373–374
production 373–375
trade conditions 378
uses 377
Wagon Wheel Gap, Colo 380–381
Formosa, coal 783–784
France, asbestos 341
asphalt 541–542
coal 783
flint pebbles 179
graphite 189
gypsum 360
ocher 55
petroleum, exports to 1062–1084
phosphate rock 279
pyrite 37
talc 154, 156
French Guiana, phosphate rock 279
French Oceania, phosphate rock 279
Front brick 549, 551, 559
Fuel briquetting, by E. W. Parker 11–16
Fuel oil 950–960
Fuller's earth, by Jefferson Middleton 109–115
bibliography 114–115
history 110
imports 113–114
industry, by States 112–113
mining and preparation 109–110
occurrence 109
prices 111
production 111–112
uses 110
Furnace flux, by States 1327
Furnace sand, production 328–331, 333

G.

Page.

Gale, Hoyt S., paper on borax 521–536
on magnesite 441–454
Galicia, petroleum 1107–1109
Garnet (abrasive), production 262–267
notes on 262–267
Gasoline from natural gas 1478–1486
(*See also* Natural gas.)
analyses 1486–1488
exports and imports 1486
production 1478–1480
by States 1479–1480
Gems and precious stones, by Douglas B. Sterrett 649–708
agate 650–654
amazon stone 668–670
amethyst 655–656
asteria quartz 704
beryl 656–663
curious lore of precious stones 705
diamond 663–668
feldspar gems 668–670
heliodor 704
hetaerolite 704
Iceland spar 704
imports 707–708
jade 671
jasper 671–674
jet 674
lapis lazuli 674
lazulite 675
metric carat 705
obsidian 675
opal 675–680
roduction, by varieties 706–707
publications 705–706
quartz 681
rhodonite 681
ruby 681, 705
spodumene 681
sunstone 670
topaz 682–688
tourmaline 688–692
turquoise 693–704, 706
Georgia, asbestos 339, 343–349
barytes 165–166, 169
brick and tile 547, 558
cement, natural 141
Portland 121–122, 126
clay 618
clay products 547, 558, 587
coal 720, 726, 824–826
coke 461, 494
fuller's earth 109, 111–112
furnace flux 1327
glass sand 327, 330
granite 1290, 1298, 1300
graphite 188, 198
gypsum 356
lime 312, 314, 317, 1533
limestone 1290, 1319, 1322–1323, 1533
marble 1290, 1314, 1317, 1533–1534
metallic paint 56
mica 2
mineral waters 394, 398, 408
ocher 51

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Page.
Georgia, pottery ... 547, 573, 577
pyrite ... 34, 37
sand and gravel ... 327–328, 330–331
sand-lime brick ... 18–19, 20
sandstone ... 1230, 1238, 1233
slate ... 75–76, 78
slate and shale for pigment ... 58
talc ... 153, 155, 160
topaz ... 682
tripoli ... 267–268, 270
German East Africa, mica ... 2
German Southwest Africa, diamond ... 667
Germany, asbestos ... 341
asphalt ... 540, 542
coal ... 783–784
feldspar ... 151
flint pebbles ... 179
graphite ... 189
gypsum ... 360
magnesite ... 444, 448, 450
ocher ... 55
peat ... 387, 388, 389, 390
petroleum ... 1112
exports to ... 1082–1084
potash salts ... 102
pyrite ... 37
quartz ... 179
talc ... 154, 156
Glass sand ... 325, 327–331, 333
(*See also* Sand and gravel.)
price ... 325
production ... 325
by States ... 327–331
Glenn pool ... 1036
Granite ... 1288, 1290, 1297–1311, 1338–1408
(*See also* Stone industry.)
imports ... 1296
production, by States ... 1288, 1298
value, by States ... 1290, 1300
by uses ... 1291, 1300
Maine production ... 1308–1305
Massachusetts production ... 1305
Minnesota production ... 1305–1306
New Hampshire production ... 1306–1307
Vermont production ... 1308–1310
Wisconsin production ... 1310–1311
Graphite, by Edson S. Bastin ... 181–251
analyses ... 201, 213, 215
Ceylon ... 189, 234–238
Chosen (Korea) ... 189, 238–239
imports ... 189
industry, by States ... 190–233
introduction ... 181
literature ... 245–251
Madagascar ... 189, 239–244
Mexico ... 189, 244–245
origin ... 183–184
physical and chemical properties ... 182–183
prices ... 233–234
production ... 188–190
amorphous ... 188
crystalline ... 188
manufactured ... 184–185, 190
uses ... 185–188
world's production ... 189
Gravel (*see also* Sand and gravel) ... 325–337
Great Basin, potash ... 85–86

Page.
Great Britain, asbestos ... 341
coal ... 783–784
imports from ... 779
flint pebbles ... 179
fluorspar ... 351
gypsum ... 359
magnesite ... 444
peat ... 388
petroleum ... 1112
exports to ... 1082–1084
talc ... 154, 155
Greece, coal ... 783
gypsum ... 359
magnesite ... 442–444, 448, 450
pyrite ... 37
Greensburg, Pa., coke district ... 586
Grinding and polishing sand ... 327–328, 330–331, 333
Grindstones, imports ... 259
production ... 256–259
by States ... 255
Canadian ... 259
Guano, imports ... 277
Guatemala, petroleum ... 1097
Gulf oil field ... 945, 948, 949, 1080–1082
Gypsum, by Ralph W. Stone ... 355–372
disposition, as to uses ... 358
imports ... 359
occurrence of gypsum and gypsite in United States by localities ... 363–372
production ... 355–359
by States ... 356
products ... 361–363
prices ... 355, 356–359
trade conditions ... 359–361
value ... 356, 358
world's production ... 359

H.

Hance, J. H., notes on occurrence and use of flint clay ... 639–645
Hawaiian Islands, granite ... 1290, 1298
lime ... 312, 314, 317
limestone ... 1290, 1319
petroleum, exports to ... 1081
salt ... 293–294, 304
sand and gravel ... 328, 330–331
trap rock ... 1290, 1312
Heliodor ... 704
Hetaerolite ... 704
Herzegovina, coal ... 783
pyrite ... 37
Hill, B., paper on natural gas ... 1411–1507
Hill, James M., paper on barytes ... 165–174
on mineral paints ... 49–70
Holland, coal ... 783
peat ... 387
Hones, imports ... 260
Hongkong, petroleum, exports to ... 1084
Hudson River district, common brick ... 565–568
Hungary, natural gas ... 1456–1459
pyrite ... 37

I.

Idaho, barytes ... 172
brick and tile ... 547, 558
clay ... 618
clay products ... 547, 558
coal ... 720, 726, 826

Digitized by Google

Page.

Idaho, diamond 665
granite 1290, 1298, 1300, 1377–1378
graphite 199
gypsum 365
lime 312, 314–317
limestone 1290, 1319, 1322–1323, 1381–1384
marble 1380
mica 2, 6
phosphate rock 273–274, 276–277, 280–281
pumice 271
salt 293–294, 297
sand and gravel 327–328, 330–331
sand-lime brick 18–19, 20
sandstone 1290, 1329, 1332–1333, 1384–1386
slate 1380
volcanic rocks 1378–1380
Illinois brick and tile 547, 558
cement, Portland 121–122, 126
natural 141
clay 618
clay products 547, 558, 588
coal 720, 726, 826–833
coke 461, 496
fluorspar 375
furnace flux 1327
gasoline from natural gas 1480, 1485
glass sand 327, 330
gypsum 356, 360
lime 312, 314, 317
limestone 1290, 1319, 1322–1323, 1535
mineral waters 394, 398, 408
natural gas 1412–1420, 1421, 1437–1439
acreage 1421
gasoline from 1480
petroleum 935–938, 945, 948, 949, 962, 1014–1023
pottery 547, 573, 577
pyrite 34, 38
sand and gravel 327–328, 330–331
sand and sandstone 180
sandstone 1290, 1329, 1332–1333
sublimed lead pigments 61
tripoli 180, 267–269
Imports, abrasives 253
alizarin 491
aniline salts 491
apatite 277
asbestos 340–341
asphalt 541
barium compounds 167
barytes 166–167
bone dust and bone ash 277
borax 522
brick and tile 581
burrstones and millstones 256
calcium cyanamid 277
cement 139–140
china and porcelain 581
clay 620
clay products 581
coal 780
coal-tar products 490
coke 490
corundum 261
cryolite 381
earthen and stone ware 581
diamond 708
diamond dust and bort 253

Page.

Imports, diatomaceous (infusorial) earth 269
emery 261
fertilizers 277–278
flint pebbles 179
fluorspar 379
fuller's earth 113–114
gasoline 1486
gems and precious stones 706
granite 1296
graphite 189
grindstones 259
guano 277
gypsum 359
hones 260
kainit 277
kaolin or china clay 620
lime 315
litharge 62
lithopone 62
magnesite 444
manure salts 277
marble 1296
mica 8
mineral waters 402
natural gas 1455
ocher 52
oilstones and scythestones 260
onyx 1296
orange mineral 62
ozokerite 541, 1080
paraffin 1080
pearls 708
peat 392
petroleum 1080–1081
phosphate rock, crude 277
potash salts 103–104, 277–278
pottery 581
pumice 271
pyrite 35–36
red lead 62
rotten stone 269
salicylic acid 491
salt 295
sand and gravel 334
sienna 54
slag, basic 277
slate 77
sodium nitrate 277–278
stone 1296
strontium 174
sulphur 24
talc 156
tripoli 260
umber 53–54
Venetian red 62
whetstones and oilstones 261
white lead 62
zinc oxide 60
India, asbestos 340
coal 783
graphite 189
gypsum 360
magnesite 450
mica 9
petroleum 1113
exports to 1084
talc 154

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Page.

Indiana, brick and tile..... 547, 558
cement, natural..... 141
Portland..... 121–122, 126
clay..... 618
clay products..... 547, 588, 590
coal..... 720, 726, 833–837
coke..... 461, 496
diamond..... 665
furnace flux..... 1327
glass sand..... 327, 330
lime..... 312, 314, 317
limestone... 1290, 1319, 1322–1323, 1334, 1535–1536
marble..... 1537
mineral waters..... 394, 398, 409
natural gas..... 1412–1420, 1434–1437
acreage..... 1421
oilstones..... 259–260
petroleum..... 935–938, 962, 973, 1011–1013
pottery..... 547, 573, 577
pyrite..... 34, 38
sand and gravel..... 327–328, 330–331
sand-lime brick..... 18–19, 20
sandstone..... 1290, 1329, 1333
slate and shale for pigments..... 58
whetstones..... 259
Indo-China, coal..... 783
Infusorial (diatomaceous) earth (*see also* Abrasives *and* silica)..... 180, 267–271
Iowa, brick and tile..... 547, 558
cement, Portland..... 121–122, 126
clay..... 618
clay products..... 547, 558, 591
coal..... 720, 726, 837–841
furnace flux..... 1327
gypsum..... 356, 365–366
lime..... 312, 314, 317, 1541
limestone..... 1290, 1319, 1322–1323, 1540–1541
mineral waters..... 394, 398, 410
natural gas..... 1413–1420, 1453
ocher..... 51
pottery..... 547, 573, 578
sand and gravel..... 327–328, 330–331
sand-lime brick..... 18–19, 20
sandstone..... 1290, 1329, 1332–1333
Irwin, Pa., coke district..... 508
Italy, asbestos..... 340–341
asphalt..... 541–542
coal..... 783
feldspar..... 151
graphite..... 189
magnesite..... 444, 450
natural gas..... 1459
peat..... 388
petroleum..... 1113
exports to..... 1083–1084
pyrite..... 37
quartz..... 179
sulphur..... 24, 28–30
talc..... 154, 156

J.

Japan, asbestos..... 341
coal..... 783–784
graphite..... 189
mica..... 2
petroleum..... 1115–1117

Page.

Japan, petroleum, exports to..... 1084
pyrite..... 37
sulphur..... 24
Java, petroleum..... 1114

K.

Kainit, imports..... 277
Kanawha, W. Va., coke district..... 519
Kansas, brick and tile..... 547, 558
cement, natural..... 141
Portland..... 121–122, 126
clay products..... 547, 558, 592
coal..... 720, 726, 841–844
coke..... 461, 497
furnace flux..... 1327
gasoline from natural gas..... 1480, 1496
gypsum..... 356, 366
leaded zinc oxide..... 61
lime..... 312, 314, 317, 1545
limestone..... 1290, 1319, 1322–1323, 1543–1545
mineral waters..... 394, 398, 410
natural gas..... 1412–1420, 1439–1441
acreage..... 1421
petroleum..... 935–939, 962, 1023, 1029–1032
pottery..... 547, 573, 578
pumice..... 271
salt..... 293–294, 297–298
notes on geology of..... 298
sand and gravel..... 327–328, 330–331
sand-lime brick..... 18–19, 20
sandstone..... 1290, 1329, 1332–1333
zinc oxide..... 59
Kaolin, or china clay, imports..... 630
production, by States..... 615, 618
Katz, Frank J., paper on abrasive materials..... 253–272
on feldspar..... 145–151
on silica (quartz)..... 175–180
Kelps of Pacific coast..... 92–96
Kentucky:
asphalt..... 539
barytes..... 165–166, 169–171
brick and tile..... 547, 558
cement, Portland..... 121–122, 126
clay..... 618
clay products..... 547, 558, 593
coal..... 720, 726, 844–850
coke..... 461, 498
fluorspar..... 375
furnace flux..... 1327
gasoline from natural gas..... 1480
glass sand..... 327, 330
lime..... 312, 314, 317, 1537
limestone..... 1290, 1319, 1322, 1325, 1537
marble..... 1290, 1314, 1537
mineral waters..... 394, 398, 410
natural gas..... 1412–1420, 1429–1430
acreage..... 1421
ocher..... 51
oilstones..... 259–260
petroleum..... 935–938, 962, 973, 992–995
phosphate rock..... 285
pottery..... 547, 573, 578
sand and gravel..... 330–331
sand-lime brick..... 18–19, 20
sandstone..... 1290, 1329, 1332–1333

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Page.
Kongo, diamond 668
Korea (Chosen), coal 78
graphite 189, 238–239
Kunzite 68
2

L.

Leaded zinc oxide 59–61
Lebanon and Schuylkill Valley, Pa., coke district 508
Lehigh district, cement 123
Lima-Indiana oil field 945, 948, 949, 1003–1013
Lime, by Ralph W. Stone 309–324
economic notes on lime 317–324
exports 315
fuels used in burning 315–317
hydrated lime 313–314, 319–321
imports 315
tariff 315
number of kilns 316–317
plants 311–312
price 311–312
production, by States 309–312
by uses 313
rank of States, by quantity 311–312
by value 311–312
uses 312–313
value 310, 312
Lime, source, manufacture, and use of, by Ernest F. Burchard and Warren E. Emley 1509–1593
introduction 1509–1510
manufacture and use of lime 1556–1593
chemical and physical properties of lime 1579–1580
general discussion 1556–1557
hydrated lime 1575–1579
manufacture of lime 1557–1575
use of lime 1580–1593
source of lime 1511–1555
age and distribution of limestones sampled 1527–1529
ages of rocks 1525–1527
character of lime produced in various States 1552–1555
distribution of limestone in United States east of Rocky Mountains 1529–1552
limestone 1511–1521
character 1514
classification 1511
origin 1512
varieties 1515–1521
overburden 1527
structure of rocks 1521–1525
thickness of sedimentary rocks 1526
Western and Pacific Coast States 1552
Limestone 1288, 1290, 1318–1328, 1338–1408
(*See also* Stone.)
analyses 1350–1351, 1381–1384
for furnace flux 1326–1327
production, by States 1290, 1319
value 1288, 1319
by States 1290, 1319
by uses 1291, 1322–1323
Limestone (*see also* Source, manufacture, and use of lime) 1511–1521, 1529–1552

Page.
Limestone, analyses 1558
Litharge, imports 62
production 62, 64
Lithopone, imports 62
production 62, 64
Louisiana, brick and tile 547, 558
clay products 547, 558
gypsum 366
limestone 1290, 1321, 1323, 1546
mineral waters 394, 398, 411
natural gas 1412–1420, 1446–1447
acreage 1421
petroleum 935–939, 962, 1040, 1055–1062
pottery 547, 573, 578
salt 293–294, 298–299
sand and gravel 327–328, 330–331
sulphur 23
Lower Connellsville, Pa., coke district 508, 512

M.

Madagascar, feldspar 151
graphite 189, 239–244
quartz 179
talc 154
Magnesite, by Charles G. Yale and Hoyt S. Gale 441–454
California 441
domestic deposits, map of 442
foreign occurrences 449–450
imports 444
magnesia cement 450
prices 443
production 441
publications 454
uses 445
utilization of product, domestic 448
foreign 448
Maine, amethyst 654
beryl 656–659
brick and tile 547, 558
clay products 547, 558
feldspar 148–149
granite 1290, 1298, 1300, 1303–1305
graphite 199
lime 312, 314, 317, 1530
limestone 1290, 1319, 1323, 1530
marble 1530
mica 2
mineral waters 394, 398, 412
pottery 547, 573, 578
quartz (gem) 681
sand and gravel 327–328, 330–331
slate 75–76, 78
topaz 682
tourmaline 688–692
Manure salts, imports 277
Marble (*see also* Stone) 1288, 1290, 1313–1317, 1338–1408
exports 1295
imports 1296
production, by States 1290, 1314
value 1288, 1314
by States 1290, 1314
by uses 1291, 1315, 1317
Marble (*see also* Source, manufacture, and use of lime) 1530–1552

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Page.

Maryland, brick and tile 547, 558
cement, Portland 121–122, 126
clay 618
clay products 547, 558, 594
coal 720, 726, 850–853
coke 461, 520
Cumberland coal 853
diatomaceous earth 180, 268
feldspar 148, 150
furnace flux 1327
glass sand 327, 330
granite 1290, 1298, 1300
lime 312, 314, 317, 1533
limestone 1290, 1319, 1322–1323, 1532–1533
marble 1290, 1314, 1317, 1533
metallic paint 56
mica 2
mineral waters 394, 398, 413
mortar colors 57
pottery 547–573, 578
quartz 177–178
sand and gravel 327, 329, 330–331
sand-lime brick 18
sandstone 1290, 1329, 1332–1333
slate 75–76, 78–79
soapstone 153, 163
talc 153, 155
Massachusetts, beryl 659–660
brick and tile 547, 558
clay 618
clay products 547, 558, 595
coke 461, 520
emery 260–261
feldspar 150
fuller's earth 109, 111–112
furnace flux 1327
glass sand 327, 330
granite 1290, 1298, 1300, 1305
graphite 199–201
lime 312, 314, 317, 1530
limestone 1290, 1319, 1322–1323, 1530
marble 1290, 1314, 1317, 1531
mineral waters 394, 398, 413
pottery 547, 573, 578
pyrite 84
quartz 177–178
sand and gravel 327–329, 330–331
sand-lime brick 18–19, 20
sandstone 1290, 1329, 1332–1333
talc 153, 155, 161
trap rock 1290, 1312
Metallic paint, notes on 56–57
prices 50, 56
production, by States 56
Metric carat 705
Mexico, asphalt 542
coal 783
graphite 189, 244
magnesite 444, 449
petroleum 1094–1095
exports to 1082–1083
imports 1080
production in 1913, by E. De Golyer. 1095
Mica, by Douglas B. Sterrett 1–9
Canada 9

Page.

Mica, general geology 2–3
imports 8
India 9
mining and treatment 3–5
prices 7–8
production 6–7
uses 5–6
Michigan, brick and tile 547, 558
bromine 307
calcium chloride 307
cement, Portland 121, 126
clay 618
clay products 547, 558, 596
coal 720, 726, 852–856
coke 461, 520
furnace flux 1327
glass sand 327, 330
granite 1290, 1298
graphite 201
grindstones 258
gypsum 356, 366–367
lime 312, 314, 317
limestone 1290, 1319, 1322–1323, 1534–1535
metallic paint 56
mineral waters 394, 398, 415
natural gas 1413–1420, 1453
petroleum 935–939, 962, 1078
pottery 547, 573, 578
quartz 177–178
salt 293–294, 299–300
sand and gravel 327–329, 330–331
sand-lime brick 18–19, 20
sandstone 1290, 1329, 1332–1333
scythestones 259–260
trap rock 1290, 1312
Mid-Continent oil field 945, 948, 949, 1022–1039
Middleton, Jefferson, paper on clay-working industries 545–648
fuller's earth 109–115
sand-lime brick 17–22
Milwaukee, Wis., coal-trade review 805–807
Millstones and burrstones 255–258
imports 256
industry 257–258
production 255–256
Mineral paints, by James M. Hill 49–70
bibliography 67–70
chemically manufactured pigments 62–65
groups of mineral paints 49–50
legislation affecting mineral paints 65–67
natural mineral pigments 50–59
production 50–51
paint tests 65
pigments made from ores 59–61
Mineral waters, by B. B. Dole 393–440
analyses 433–434
character of statistics 393–394
condition of trade 396–400
exports 402
imports 402
number of springs 394–395
price per gallon 400–401
production, by States 394–395
increase or decrease 398–399
radioactivity of 435–440

Digitized by Google

Page.
Mineral waters, trade, by States 402–433
soft drinks 401
value 394–400
Minnesota, brick and tile 547, 558
cement, natural 141
clay 618
clay products 547, 558, 597
coke 461, 520
feldspar 148, 150
fuller's earth 109, 112
furnace flux 1327
granite 1290, 1298, 1300, 1305–1306
gypsum 356
lime 312, 314, 317, 1539
limestone 1290, 1319, 1322–1323, 1537–1539
mineral waters 394, 398, 416
pottery 547, 573, 578
sand and gravel 327–329, 330–331
sand-lime brick 18–19, 21
sandstone 1290, 1329, 1332–1333
Mississippi, brick and tile 547, 558
clay products 547, 558
fuller's earth 109, 112
limestone 1533
mineral waters 394, 398, 416
petroleum, acreage 962
pottery 547, 573, 578
sand and gravel 327–329, 330–331
sand-lime brick 18
Missouri, barytes 165–166, 171
brick and tile 547, 558
cement, Portland 121–122, 126
clay 618
clay products 547, 558, 598
coal 720, 726, 856–860
coke 461
furnace flux 1327
glass sand 327, 330
granite 1290, 1298, 1300
lime 312, 314, 317, 1542–1543
limestone 1290, 1319, 1322–1323, 1325, 1542–1543
metallic paint 56
mineral waters 394, 398, 417
natural gas 1412–1420, 1442
acreage 1421
petroleum 925–930, 962, 1077
pottery 547, 573, 578
pyrite 34, 38
sand and gravel 328, 331
sandstone 1290, 1329, 1332–1333
sublimed blue lead 59–61
sublimed white lead 59–61
tripoli 180, 267–269
Molding sand, production 326–328, 330–331, 333, 334–336
price 326
Montana, agate 652–654
brick and tile 547, 558
cement, Portland 121–122, 126
clay 618
clay products 547, 558
coal 720, 726, 861–863
coke 461, 499
furnace flux 1327
granite 1290, 1298, 1300
graphite 202–204
grindstones 258
Montana, gypsum 356, 367
lime 312, 317, 1549
limestone 1290, 1319, 1322–1323, 1549–1550
marble 1550
mineral waters 394, 398, 418, 1550
natural gas 1454
phosphate rock 280–281
pottery 547, 573, 578
sand and gravel 327–329, 330–331
sand-lime brick 18
sandstone 1290, 1329, 1332–1333
Mortar colors, prices 50, 57
production, by States 51, 57

N.

Natal, asbestos 340
coal 783
phosphate rock 279
Natural cement (*see* Cement) 141–142
Natural gas, by B. Hill 1411–1507
analyses of 1460–1478, 1487
acreage controlled by natural-gas companies, by States 1421
carbon black 1488–1499
cities supplied with natural gas 1499–1507
combined value of gas and petroleum, by States 1419–1420
composition of natural gas from various sources 1459–1478
consumption 1412–1419
consumers 1415–1416
distribution 1415–1418
gasoline from 1478–1486
analyses of, for gasoline content 1486–1488
exports and imports 1486
prices 1479–1480
production 1478–1480
in foreign countries 1455–1459
imports 1455
industry in individual States 1421–1455
number of producers 1415–1416
prices 1414–1418
production 1412–1419
quantity of natural gas produced 1414
value, by States 1414–1419
consumed, by States 1414, 1419
well record, by States 1420
Navy, U. S., fuel oil 955–960
Nebraska, brick and tile 547, 558
clay products 547, 558
fuller's earth 109
lime 1541
limestone 1290, 1319, 1322–1323, 1541
mineral waters 394, 398, 418
pottery 573
pumice 271
sand and gravel 328–329, 330–331
sand-lime brick 18, 19, 21
sandstone 1290, 1329, 1333
Netherlands, asbestos 341
asphalt 542
magnesite 444, 448
petroleum, exports to 1083–1084
talc 156
Nevada, barytes 172
brick and tile 547, 558
clay products 547, 558

Digitized by Google

Page.

Nevada, coal 720
diatomaceous earth 180, 268
granite 1290, 1298, 1368–1370
graphite 188, 204
gypsum 356, 367
lime 312, 317
limestone 1290, 1319, 1375
marble 1373–1374
mica 2
mineral waters 394, 398, 418
opal 677–680
potash 85–86
salt 293–294, 300
sand and gravel 329, 330–331
sandstone 1290, 1329, 1375
turquoise 697, 699
volcanic rocks 1370–1373
New Brunswick, gypsum 359
New Caledonia, magnesite 450
Newfoundland, flint 179
pyrite 37
New Hampshire, beryl 660–663
brick and tile 547, 558
clay products 547, 558
fluorspar 375
garnet, abrasive 262, 265–267
granite 1290, 1298, 1300, 1306–1307
mica 2, 6
mineral waters 394, 398, 419
pottery 547, 573
sand and gravel 331
scythestones 259–260
topaz 683–684
New Jersey, brick and tile 547, 558
cement, Portland 121–122, 126
clay 618
clay products 547, 558, 600
coke 461
furnace flux 1327
glass sand 327, 330
granite 1290, 1298, 1300
graphite 204–206
lime 312, 314, 317, 1531
limestone 1290, 1319, 1322–1323, 1532
mineral waters 394, 398, 419
pottery 547, 573, 579
sand and gravel 327–329, 330–332
sand-lime brick 18–19, 21
sandstone 1290, 1329, 1332–1333
slate 75–76, 79
for pigment 58
talc 153, 155, 161
trap rock 1290, 1312
zinc oxide 60
New Mexico, brick and tile 547, 558
clay 618
clay products 547, 558
coal 720, 726, 864–866
coke 461, 499
fluorspar 375
granite 1290, 1298, 1300
graphite 206–207
gypsum 356, 368
lime 312, 317, 1552
limestone 1290, 1319, 1322–1323, 1552
marble 1290, 1314, 1552

Page.

New Mexico, mica 2, 6
mineral waters 394, 398, 420
petroleum 935–939, 962, 1073
pottery 547, 573
salt 293–294
sand and gravel 327–329, 330–332
sandstone 1290, 1329, 1332, 1333
turquoise 699–703
Newport News, coal-trade review 798–800
New River, W. Va., coke district 519
New South Wales, coal 783
magnesite 450
petroleum 1113
New York, bluestone 1290, 1334
brick and tile 547, 558, 565–566
burrstones 257
cement, collos 142–146
natural 143
Portland 121–122, 121
puzzolan 143
clay 547
clay products 547, 558, 602
coke 461, 500
diamond 666
diatomaceous earth 180, 268
emery 260–261
feldspar 148, 150
fuller's earth 109, 112
furnace flux 1327
garnet, abrasive 262–265
gasoline from natural gas 1480, 1496
glass sand 327, 330
granite 1290, 1298, 1300
graphite 188, 207–220
gypsum 356, 360, 368–369
lime 312, 314, 317, 1531
limestone 1290, 1319, 1322–1323, 1531–1532
marble 1290, 1314, 1317, 1532
metallic paint 56
mica 2, 6
millstones 256–257
mineral waters 394, 398, 420
mortar colors 57
natural gas 1412–1420, 1424–1426
acreage 1421
gasoline from 1480
petroleum 935–938, 962, 973, 985–988
pottery 547, 573, 579
pyrite 34, 38
quartz 177–178
salt 293–294, 300–301
sand and gravel 327–329, 330–332
sand-lime brick 18–19, 21
sandstone 1290, 1329, 1332–1333
slate 75–76, 79
and shale, for pigment 58
talc 153, 155, 161–162
trap rock 1290, 1312
New York City, coal-trade review 784–790
New Zealand, coal 783
mica 2
petroleum 1118
sulphur 30
Norfolk and Newport News, coal trade 798–800
North Carolina, amethyst 655
barytes 165–166

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Page.
North Carolina, brick and tile..... 547, 558
clay..... 618
clay products..... 547, 558, 603
coal..... 726
feldspar..... 148, 150
furnace flux..... 1327
garnet, abrasive..... 262, 267
granite..... 1290, 1298, 1300
graphite..... 220
lime..... 312, 314, 317, 1533
limestone..... 1290, 1319, 1323, 1532–1533
marble..... 1290, 1314, 1533
mica..... 2, 6
millstones..... 256, 258
mineral waters..... 394, 398, 422
pottery..... 547, 573, 579
quartz..... 177–178
ruby..... 681
sand and gravel..... 327–329, 330–331
sandstone..... 1290, 1329, 1333
soapstone..... 153, 163
talc..... 153, 155, 162
North Dakota, brick and tile..... 547, 558
clay..... 618
clay products..... 547, 558
coal..... 720, 726, 866–870
limestone..... 1539
mineral waters..... 394, 398, 422
natural gas..... 1412–1420, 1454
sand and gravel..... 327–329, 330–332
sand-lime brick..... 18–19, 21
sandstone..... 1329
Northern coal field, production..... 736
Norway, feldspar..... 151
graphite..... 189
magnesite..... 443–444, 450
mica..... 2
petroleum, exports to..... 1083
pyrite..... 37
Nova Scotia, coal, imports from..... 779
gypsum..... 359

O.

Ocher, imports..... 52
notes on..... 52–53
prices..... 50–51
production, by States..... 51
world's production..... 55
Ohio, brick and tile..... 547, 558, 564
bromine..... 307
calcium chloride..... 307
cement, natural..... 141
Portland..... 121–122, 126
puzzolan..... 143
clay..... 618
clay products..... 547, 558, 604
coal..... 720, 726, 870–875
coke..... 461, 501
furnace flux..... 1327
gasoline from natural gas..... 1480, 1483
glass sand..... 327, 330
grindstones..... 258
gypsum..... 356, 369
lime..... 312, 314, 317, 1537
limestone..... 1290, 1319, 1322–1323, 1536
mineral waters..... 394, 398, 422
Ohio, mortar colors..... 57
natural gas..... 1412–1420, 1431–1434
acreage..... 1421
gasoline from..... 1480
oilstones..... 259–260
petroleum..... 935–938, 962, 973, 996–1003
pottery..... 547, 573, 579
pyrite..... 34, 40
salt..... 293–294, 301–302
sand and gravel..... 327–329, 330–332
sand and sandstone..... 180
sand-lime brick..... 18–19, 21
sandstone..... 1290, 1329, 1332–1333
whetstones..... 259
Oilstones and scythestones..... 259–260
imports..... 260
production..... 259–260
Oklahoma, asphalt..... 539
brick and tile..... 547, 558
cement, Portland..... 121–122, 126
clay products..... 547 558
coal..... 720, 726, 875–878
coke..... 461, 503
furnace flux..... 1327
gasoline from natural gas..... 1480, 1484
granite..... 1290, 1298, 1300
gypsum..... 356, 360, 369–370
lime..... 312, 317, 1547
limestone..... 1290, 1319, 1322–1323, 1546–1547
marble..... 1314, 1547–1548
mineral waters..... 394, 398, 423
natural gas..... 1412–1420, 1442–1445
acreage..... 1421
petroleum..... 935–939, 962, 1023, 1032–1039
potash salts..... 89
pottery..... 580
pyrite..... 34
salt..... 293–294, 302
sand and gravel..... 327–329, 330–332
sand-lime brick..... 18–19, 21
sandstone..... 1329–1333
tripoli..... 267, 269
Ontario, corundum..... 261
natural gas..... 1455–1456
petroleum..... 1082, 1091–1094
Onyx marble (*see also* Stone)..... 1343, 1349
imports..... 1296
Orange Free State, coal..... 783
diamond..... 667
Orange mineral, imports..... 62
production..... 62, 64
Oregon, agate..... 654
brick and tile..... 547, 558
clay..... 618
clay products..... 547, 558
coal..... 720, 726, 878–879
furnace flux..... 1327
granite..... 1290, 1298, 1300, 1388
gypsum..... 356, 370
jasper..... 674
lime..... 312, 317
limestone..... 1290, 1319, 1323, 1395
marble..... 1314, 1394
mineral waters..... 394, 398, 424
natural gas..... 1413–1419
ocher..... 51

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Page.

Oregon, opal ... 699
pottery ... 547, 573, 580
sand and gravel ... 327–329, 330–332
sandstone ... 1290, 1229, 1232, 1295–1297
slate ... 1299
trap rock ... 1299, 1312
volcanic rocks ... 1299–1298
Osmerite ... 541, 1060

P.

Pacific coal field, production ... 734
Paint tests ... 65
Panama, petroleum, exports ... 1052
Paper clay ... 615–618
Paraffin oil, imports ... 1060
Parker, Edward W., paper on coal ... 709–928
coke ... 455–520
fuel briquetting ... 11–16
Patents for extraction of potash ... 98–101
Paving sand, production ... 328–329, 331–332, 333
Pearl, imports ... 708
Peat, by Charles A. Davis ... 383–392
briquetted peat ... 387
coke or charcoal ... 388
consumption ... 392
European methods of producing peat for fuel ... 384–385
fuel in special industries ... 389–390
for steam plants ... 389
imports ... 392
pressing water from peat ... 386–387
prices ... 391
powder ... 387
producer gas ... 388–389
production ... 392
uses, commercial, in Europe ... 390
domestic ... 390–392
fertiliser filler ... 391
fuel ... 390
moss litter ... 392
paper stock ... 391
stock food ... 391
Pennsylvania, bluestone ... 1290, 1294
brick and tile ... 547, 558
bromine ... 307
calcium chloride ... 307
cement, natural ... 141
Portland ... 121–123, 126
puzzolan ... 143
clay ... 618
clay products ... 547, 558, 606
coal ... 720, 736, 880–901
anthracite ... 883–896
bituminous ... 896–901
coke ... 461, 503
feldspar ... 148, 150
furnace flux ... 1327
garnet (abrasive) ... 267
gasoline from natural gas ... 1480, 1481–1482
glass sand ... 327, 330
granite ... 1290, 1298, 1300
graphite ... 188, 221–228
lime ... 312, 314, 317, 1531
limestone ... 1290, 1319, 1322–1323, 1531–1532
marble ... 1290, 1314, 1532

Page.

Pennsylvania, metallic paint ... 85
mica ... 2, 6
millstones ... 256, 258
mineral waters ... 394, 396, 434
mortar colors ... 57
natural gas ... 1412–1429, 1432–1434
acreage ... 1421
gasoline from ... 1480
ocher ... 51
petroleum ... 935–938, 962, 973, 984–988
pottery ... 547, 573, 580
pyrite ... 34
quartz ... 177–178
salt ... 298–304, 302
sand and gravel ... 327–329, 329–332
sand and sandstone ... 180
sand-lime brick ... 18–19, 21
sandstone ... 1290, 1229, 1232–1233
sienna ... 53–54
slate ... 75–76, 79–82
slate and shale for pigment ... 58
talc ... 153, 155, 161
trap rock ... 1299, 1312
tripoli ... 180, 267–268, 270
umber ... 53–54
zinc oxide ... 60
Peru, coal ... 783
petroleum ... 1099–1101
Petroleum, by David T. Day ... 929–1284
acknowledgments ... 934
Africa ... 1118–1121
Alaska ... 985, 1060
analyses of petroleum ... 1121–1279
general statement ... 1121–1123
method of analysis ... 1123–1125
Appalachian oil field ... 944–946, 949, 970–1008
general conditions ... 970
pipe-line statistics ... 975–980
runs ... 975–976
deliveries ... 978–980
stocks ... 976–978
prices ... 945, 980–982
production ... 971
average, daily, by months and years ... 975
by States ... 973–974
increase and decrease ... 973
well record ... 949, 982–984
Argentina ... 1062, 1101
Arkansas ... 1078
Australia ... 1113
Austria-Hungary ... 1107–1109
Bolivia ... 1099
California oil field ... 945, 948, 949, 1062–1070
conditions ... 1062
field report ... 1070
production ... 1067–1069
transportation ... 1064–1066
by pipe line ... 1064–1066
railroad ... 1066
tank steamer ... 1066
Canada ... 1062, 1091–1094
Central America ... 1063, 1097–1098
China ... 1084, 1115
Chile ... 1063, 1101–1102

Digitized by Google

Page.
Petroleum, Colombia ... 1098
Colorado ... 945, 948, 949, 1071–1074
field report ... 1074
consumption of kerosene, per head of population ... 1062
deliveries, by fields ... 946, 948
Dutch East Indies ... 1114
Ecuador ... 1098
Egypt ... 1118
exports ... 1080–1090
by calendar years ... 1085–1090
by fiscal years ... 1082–1084
shipments, foreign ... 1081–1090
territorial ... 1080–1081
foreign oil fields ... 1091–1121
fuel oil ... 950–960
consumption ... 951, 953
general statement ... 950
prices ... 952
railroads ... 952–955
United States Navy ... 955–960
curves showing relation of viscosity to temperature ... 957
flash points ... 956
pumping capacity of oils ... 956
Galicia ... 1107–1109
Germany ... 1112
Great Britain ... 1112
Guatemala ... 1097
Gulf oil field ... 945, 948, 949, 1039–1062
exports ... 1086–1088
general conditions ... 1039
pipe-line runs, deliveries, and stocks ... 1042
prices ... 1042–1043
production ... 1039–1041
shipments ... 1050, 1059, 1086–1089
stocks ... 1042
well record ... 1043–1045
Hawaiian Islands ... 1061
Illinois oil field ... 945, 948, 949, 1014–1023
general conditions ... 1014
pipe-line runs, deliveries, and stocks ... 1018–1019
prices ... 1020
production ... 1017
shipments in tank cars ... 1019
well record ... 1021–1023
imports ... 1079–1080
increase and decrease, by States ... 935
India ... 1084, 1113
Indiana ... 1011–1013
introduction ... 929–932
Italy ... 1113
Japan ... 1115–1117
Kansas ... 1029–1032
Kentucky ... 992–995
Lima-Indiana oil field ... 945, 948–949, 1003–1013
deliveries ... 948, 1007
pipe-line runs ... 948, 1006–1007
prices ... 1004, 1005, 1007–1008
production ... 1003
stocks ... 948, 1007
well record ... 949, 1008–1010
Louisiana ... 1055–1062
methods of collecting statistics ... 932–933
Mexico ... 1080, 1082–1083, 1094–1095

Page.
Petroleum, Mexico, exports to ... 1082
imports ... 1080
production in 1913, by E. De Golyer ... 1095
Michigan ... 1078
Mid-Continent oil field ... 945, 948, 949, 1023–1039
Caddo ... 1055–1061
Glenn pool ... 1036
Osage county ... 1034–1035
pipe-line runs, deliveries, and stocks ... 1026
prices ... 1026–1027
production ... 1023
well record ... 1027–1029
Missouri ... 1077
New Mexico ... 1078
New South Wales ... 1113
New York ... 985–988
New Zealand ... 1118
Ohio ... 996–1003
Oklahoma ... 1032–1039
operators' statistics ... 960–970
Pennsylvania ... 984–988
Peru ... 1099–1101
Philippines ... 1117
pipe-line statistics ... 970–1079
Porto Rico ... 1081
prices ... 945, 952, 1090–1091
production ... 935–948
by fields ... 944–946
by States ... 935
from 1859 to 1913, by States ... 937–939
in United States and in world from 1859 to 1913 ... 940
increase or decrease, by States ... 935
by fields ... 945
percentage of, by fields ... 945
by States ... 936–937
rank of producing States, by quantity ... 936
by value ... 937
Roumania ... 1109–1112
Russia ... 1102–1107
Somaliland ... 1118
South Africa ... 1118–1121
stocks ... 947
decrease ... 948
Survey publications on ... 1280–1284
Tennessee ... 995
Texas ... 1045–1055, 1086–1089
Timor ... 1114
Trinidad ... 1096–1097
Utah ... 949, 1074–1075
value ... 929, 935, 937
Venezuela ... 1082, 1096
well record ... 948–949
West Indies ... 1083, 1097–1098
West Virginia ... 988–992
world's production ... 941–943
by countries and by years ... 941–943
Wyoming ... 945, 948, 949, 1075–1077
Phalen, W. C., paper on phosphate rock ... 273–289
potash salts ... 85–107
salt, bromine, and calcium chloride ... 291–307
sulphur, pyrite, and sulphuric acid ... 23–47
Philadelphia, Pa., coal-trade review ... 790–792
Philippine Islands, asphalt ... 540
coal ... 783
mica ... 2

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Page.

Philippine Islands, petroleum exports to. 1061, 1117
Phosphate rock, by W. C. Phalen..... 273, 289
Algerian rock phosphate industry..... 286–288
cost of mining..... 288
of transportation..... 288
deposits..... 286
exports..... 287
local manufacture..... 288
market..... 288
Setif district..... 287
Tebessa district..... 286–287
bibliography..... 288–289
exports..... 278–279
imports..... 277–278
fertilizers..... 277–278
industry in Southern States..... 281–286
Arkansas deposits..... 285
Florida deposits..... 281–282
Kentucky deposits..... 285
South Carolina deposits..... 284–285
Tennessee deposits..... 282–284
Virginia deposits..... 285–286
mined..... 274
notes on domestic industry..... 280–281
phosphate reserves..... 280–281
lands withdrawn..... 281
southern fields..... 280
western fields..... 280
prices..... 273, 275, 276, 277
production, marketed..... 273, 277
by States and kinds..... 273
stock..... 275
Washington..... 1078–1079
world's production..... 279
Pittsburgh, Pa., coal-trade review..... 800–801
coke district..... 508
Porcelain electrical supplies, production.... 570, 574
Portland cement, production, by States.... 120–121
(*See also* Cement.)
Porto Rico, brick and tile..... 547, 558
clay products..... 547, 558
lime..... 312
petroleum exports to..... 1061
pottery..... 547, 573, 580
salt..... 293–294, 304
Portugal coal..... 783
petroleum exports to..... 1063
pyrite..... 37
Potash salts, by W. C. Phalen..... 85–107
alunite as source of potash salts..... 90–92
analyses..... 90
composition as mineral..... 90
fertilizer..... 96–98
method of recovering potash..... 91
Survey work on..... 91
Utah, new occurrence..... 91–92
utilization..... 92
analyses..... 90
bibliography..... 106
consumption in United States..... 104
development of deposits..... 87–90
California, Searles Lake..... 87–88
Nevada..... 85–86
Oklahoma..... 89
Texas..... 89–90
fertilizers, imports..... 103–104

Page.

Potash salts, fertilizers, industry..... 105–106
German potash statistics..... 102
Great Basin region..... 85–86
imports..... 103–104, 277–278
investigation in 1913..... 85–85
by the Survey..... 85
kelp as source of potash salts..... 93–96
investigations, private..... 92–93
as fertilizer..... 96–98
by Bureau of Soils..... 93–94
utilization..... 94–95
silicate rocks, source of..... 98–101
term "potash"..... 86–87
Pottery, consumption..... 577
establishments operating..... 573–574
exports..... 582
imports..... 581
industry by States..... 577–581
products, by kinds and States..... 573–574
rank of producing States..... 573–574
value, by States..... 573–574
varieties..... 570
Prices, asbestos..... 339–340
barytes..... 106
borax..... 522
brick..... 551, 555
cement, Portland..... 129–131
clay..... 615
clay products..... 551, 555–558
coal..... 720, 769–770
coke..... 458
Connellsville, Pa., coke..... 512
cryolite..... 351
feldspar..... 147
fluorspar..... 373–374
fuller's earth..... 111
gasoline..... 1479–1480
glass sand..... 325
graphite..... 233–235
gypsum..... 355, 358–359
lime..... 311–312
magnesite..... 443
metallic paint..... 50, 56
mica..... 7–9
mineral waters..... 400–401
molding sand..... 326
mortar colors..... 50, 57
natural gas..... 1414–1418
ocher..... 50–51
peat..... 291
petroleum..... 935, 945, 952, 1026, 1090–1091
phosphate rock..... 273, 275, 276, 277
pyrite..... 34
quartz..... 177
salt..... 291
sand and gravel..... 325
sand-lime brick..... 19
sienna..... 50, 53
slate..... 72–73
and shale..... 50, 58
soapstone..... 154, 163
sulphuric acid..... 47
talc..... 154, 157
umber..... 50, 53
Pulpstones..... 288–289
(*See also* Grindstones.)

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Page.

Pumice, imports 271
production 271
Puzzolan cement 142-143
(*See also* Cement.)
Pyrite 34-42
(*See also* Sulphur, pyrite, and sulphuric acid.)
analysis of Virginia pyrite 41
imports 35-36
industry, by States 37-41
prices 34
production, by States 34-35
utilization of pyrite residues 41-42
world's production, by countries 36-37

Q.

Quartz (*see also* Silica) 176-179
imports, flint 179
industry, by States 178
prices 177
production, by States 177
in principal producing countries 179
Queensland, coal 783
magnesite 450

R.

Radioactivity of mineral waters, by R. B. Dole 435-440
(*See also* Mineral Waters.)
bibliography 439-440
introduction 435
measurement of radioactivity 435
radioactivity of well-known waters 436
therapeutic uses of radioactive waters 438
Railroad ballast sand 331, 332, 333
Red earthenware, production 570, 573
Red lead, imports 62
production 62-64
Reynoldsville-Walston (Pa.) coke district 508
Rhode Island, brick and tile 547, 558
clay products 547, 558
furnace flux 1327
granite 1290, 1298, 1300
graphite 188, 228-229
lime 312, 317
limestone 1319, 1323
mineral waters 394, 398, 426
soapstone 153, 163
Rhodesia, asbestos 340
coal 783
magnesite 450
Rockingham ware, production 570, 573
Rocky Mountain coal field, production 736
Rotten stone 269
(*See also* Diatomaceous earth and tripoli.)
Roumania, coal 783
petroleum 1109-1112
Russia, asbestos 340-341, 352-353
asphalt 541
coal 783-784
graphite 189
peat 388, 389-390
petroleum 1102-1107
pyrite 37
Russia, Asiatic, coal 783

S.

Page.

Salicylic acid, imports 491
Salt, bromine, and calcium chloride, by W. C. Phalen 291-307
Salt (*see also* Salt, bromine, and calcium chloride) 291-306
bibliography 304-306
domestic consumption 294-295
exports 295-296
imports 295
increase or decrease 294
industry, by States 296-304
number of operating plants 294
prices 291
production marketed 291-294
by grades 291-292
by States 293-294
of brine salt 292
of rock salt 292-293
rank of States 296
Sand and gravel, by Ralph W. Stone 325-337
for filtration plants 336-337
for steel molding 334-336
gravel 328-329, 331-332, 334
imports 334
sand, building 327-328, 330-331, 333
engine 327-328, 330-331, 333
fire 327-328, 330-331, 333
furnace 328-329, 330-331, 333
glass 325, 328-330-331, 333
grinding 327-328, 330-331, 333
molding 326, 327-328, 330-331, 333, 334, 336
paving 328-329, 331-332, 333
railroad ballast 331-332, 333
production 325
by States 327-332
Sand and sandstone (*see also* Silica) 179-180
prices 180
production 180
value 180
Sand-lime brick, by Jefferson Middleton 17-22
industry by States 20-22
literature 22
price 19
production, by States 18-19
value 18-19
Sandstone 1288, 1290, 1328-1334, 1338-1408
production, by States 1290, 1329
value, by States 1288, 1290, 1329
by uses 1291, 1332-1333
San Francisco, coal-trade review 808-809
Sanitary ware, product, value 570, 574
Scotland, asbestos 341
Scythestones 259-260
(*See* Oilstones.)
Sea water, mineral salts in 1513
Searles Lake, Cal., potash 87-89
Servia, coal 783
pyrite 37
Sewer pipe, value 549, 551, 559
Shale, ground for pigment 57-58
notes on 58
production 51, 58
Sicily, sulphur 28-30
Sienna, imports 54
notes on 54-55

Digitized by Google

Page.

Sienna, prices 50, 53
production 53
Silica (quartz), by F. J. Katz 175–180
diatomaceous earth 180
flint or chert 179
quartz 176–179
sand and sandstone 179–180
tripoli 180
uses 175–176
Silicate rocks, potash from 98–101
Slag, basic, imports 277
Slate, by A. T. Coons 71–84
analyses 83, 1348
classification 72–74
conditions of industry 71–72
changes in output and value 71–72
exports 77
imports 77
industry, by States 77–84
mill stock 72–76
prices per square 73
per square foot 72
production, by States 75–76
in Pennsylvania 79–82
publications 84
roofing 73–76
value, by States 75–76
Slate and shale for pigment 57–58
notes on 58
production 51, 58
Slip clay 615–618
Soapstone (*see also* Talc and soapstone) 162–163
California 1363
prices 163
production, by States 163
Sodium nitrate 277–278
Somaliland, petroleum 1118
South Africa, coal 783
diamond 667
graphite 189
mica 2
petroleum 1118–1121
talc 154
South America, coal, exports to 779
petroleum, exports to 1062–1064
phosphate rock 279
South Australia, mica 2
magnesite 450
South Carolina, amethyst 655
barytes 165–166
beryl 663
brick and tile 547, 558
clay 618
clay products 547, 558
fuller's earth 109, 111–112
glass sand 327, 330
granite 1290, 1298, 1300
lime 312, 1533
limestone 1319, 1533
marble 1314, 1533
mica 2, 6
mineral waters 394, 398, 426
phosphate rock 273–275, 276, 280, 284–285
pottery 547, 573, 580
sand and gravel 327–329, 330–332
South Dakota, brick and tile 547, 558

Page.

South Dakota, clay products 547, 558
fuller's earth 109, 112
granite 1290, 1298, 1300
gypsum 356, 370
lime 312, 314, 317, 1540
limestone 1290, 1319, 1322–1328, 1539–1540
marble 1540
mica 2, 6–7
mineral waters 394, 398, 426
natural gas 1412–1420, 1454
pumice 271
sand and gravel 327–329, 331–332
sand-lime brick 18–19, 21
sandstone 1290, 1329, 1332–1333
Spain, asphalt 541
coal 783
ocher 55
petroleum, exports to 1062
pyrite 37
talc 154
Spitsbergen, coal 783
St. Louis, Mo., coal-trade review 807–808
Sterrett, Douglas B., paper on mica 1–9
gems and precious stones 649–708
Stone, Ralph W., paper on sand and gravel 325–337
on gypsum 355–372
on lime 309–324
Stone industry, by E. F. Burchard 1285–1410
analyses 1348, 1350, 1351, 1352, 1353, 1354
bluestone 1288, 1290, 1334
building 1291
crushed stone 1291, 1292–1295
curbstone 1291–1292
directories of stone quarries 1346, 1353–1354, 1364–1366, 1385–1387, 1397–1398, 1407–1408
exports 1295
flagstone 1291–1292
furnace flux 1327–1328
granite 1288, 1290, 1297–1311
imports 1296
introduction 1285–1287
limestone 1288, 1290, 1318–1328
marble 1288, 1290, 1312–1317
monumental stone 1291
paving 1291–1292
production 1288–1295
by States 1290
quarry maps 1325–1328
Arizona and Utah 1328–1354
California and Nevada 1354–1376
Idaho, Oregon, and Washington 1376–1406
rank of States 1290
resources in the States west of the Rocky Mountains 1325–1406
sandstone 1288, 1290, 1328–1334
Survey publications on 1408–1410
tariff 1296–1297
trap rock 1288, 1290, 1312–1313
unit of measurement 1287
value, by kind 1288
by States 1290
by uses 1291
Stoneware clay, production, by States 615–618
Stoneware, production 570, 573
Stove lining 549, 551, 560

Digitized by Google

Page.

Strikes in coal mines..... 757–759
Strontium, imports..... 174
(*See also* Barytes.)
production..... 174
Sublimed blue lead..... 59–61
white lead..... 59–61
Sulphur, pyrite, and sulphuric acid, by W. C. Phalen..... 23–47
analyses..... 32
desulphuring processes..... 31–34
exports..... 25
foreign sulphur industry..... 28–30
imports, by countries..... 24
by customs districts..... 24
Italy..... 28–30
New Zealand..... 30
occurrence and industry..... 25–28
Texas..... 23, 25–27
Bryan Heights, new mine..... 25–27
Wyoming..... 23, 27–28
production..... 23
Sulphuric-acid industry in United States..... 43–47
(*See also* Sulphur, pyrite, and sulphuric acid.)
notes on sulphuric acid figures..... 45–47
production..... 44–45
from smelter gases..... 47
uses..... 43–44
Sumatra, petroleum..... 1114
Sweden, coal..... 783
feldspar..... 151
graphite..... 189
peat..... 387, 390
petroleum, exports to..... 1063
pyrite..... 37
quartz..... 179
Switzerland, asbestos..... 341
asphalt..... 542
coal..... 783

T.

Talc and soapstone, by J. S. Diller..... 153–163
development of industry..... 153–154
distribution in United States..... 155
prices..... 154
production, total marketed..... 153–154
production by States..... 153
in principal countries..... 154
Talc (*see also* Talc and soapstone), analyses..... 158
imports..... 156
industry, by States..... 157–162
prices..... 157
production..... 155–156
section of deposit near Tecopa, Cal..... 158
section of deposit on Sheep Creek, Cal..... 159
Tariff, asphalt..... 542
borax..... 522
brick and tile..... 569
clay..... 620
coal..... 780–781
gems and precious stones..... 706
lime..... 315
magnesite..... 445
mineral paints..... 65–67
pottery..... 569
stone..... 1296–1297

Page.

Tasmania, coal..... 783
magnesite..... 450
Tennessee, barytes..... 165, 166, 171
brick and tile..... 547, 558
cement, Portland..... 121–122, 126
clay..... 618
clay products..... 547, 558, 608
coal..... 720, 726, 901–904
coke..... 461, 513
feldspar..... 151
furnace flux..... 1327
glass sand..... 328, 331
lime..... 312, 314, 317, 1533–1534
limestone..... 1290, 1319, 1322–1323, 1533
marble..... 1290, 1314, 1317, 1533, 1534, 1537
metallic paint..... 56
mineral waters..... 394, 398, 427
mortar colors..... 57
natural gas..... 1412–1420, 1431
acreage..... 1421
ocher..... 51
petroleum..... 935, 938, 995
phosphate rock..... 273–276, 280, 282–284
pottery..... 547, 573, 580
quartz..... 177–178
sand and gravel..... 328–329, 331–332
sandstone..... 1329, 1333
slate..... 75, 88
tripoli..... 180, 267–270
Terra cotta, architectural, value..... 549, 551, 559
Texas, asphalt..... 539
brick and tile..... 547, 558
cement, natural..... 141
Portland..... 121–122, 126
clay..... 618
clay products..... 547, 558, 609
coal..... 720, 726, 904–907
fuller's earth..... 109, 111–112
furnace flux..... 1327
granite..... 1290, 1298, 1300
graphite..... 229–231
gypsum..... 356, 370–371
jet..... 674
lime..... 312, 314, 317, 1548
limestone..... 1290, 1319, 1322–1323, 1548,
marble..... 1314, 1549
mineral waters..... 394, 398, 428
natural gas..... 1412–1420, 1448–1450
acreage..... 1421
opal..... 680
petroleum..... 935–939, 962, 1040, 1086–1089
potash salts..... 89–90
analysis..... 90
pottery..... 547, 573, 580
salt..... 298–304, 302–308
sand and gravel..... 328–329, 331–332
sand-lime brick..... 18–19, 21
sandstone..... 1290, 1329, 1332–1333
sulphur..... 23, 25–27
topaz..... 684–685
turquoise..... 703–704
Tile (not drain), value..... 549, 551, 560, 564
Transvaal, asbestos..... 340
coal..... 783
magnesite..... 450
Trap rock, production, by States and uses... 1288, 1290, 1312–1313

Digitized by Google

Page.
Trinidad, asphalt 540, 543
petroleum 1096-1097
Tripoli (*see* Abrasives *and also* Silica) .. 180, 267-271
imports 269
notes on 269, 271
production 268-269
Tunis, phosphate rock 279
Turkey, asphalt 542
coal 783
pyrite 37

U.

Umber, imports 53-54
notes on 54-55
principal producing countries 55
prices 50, 53
production 53
Union of South Africa, diamond 667
mica 2
United Kingdom, asbestos 341
asphalt 542
gypsum 360
magnesite 444
natural gas 1459
ocher 55
peat 388
petroleum, exports to 1062-1064
pyrite 37
talc 154, 156
Upper Connellsville, Pennsylvania, coke district 508
Upper Monongahela, West Virginia, coke district 519
Upper Potomac, West Virginia, coke district. 519
Uruguay, petroleum, exports to 1063
Utah, alunite 91-92
asphalt 539-540
brick and tile 547, 558
cement, Portland 121-122, 126
clay 618
clay products 547, 558
coal 720, 726, 907-910
coke 461, 520
fuller's earth 109, 113
furnace flux 1327
granite 1290, 1298, 1300, 1347
graphite 231
grindstones 258
gypsum 356, 371
jasper 674
lime 312, 317
limestone 1290, 1319, 1322-1323, 1350-1352
marble 1314, 1348
mica 2
mineral waters 394, 398, 429
obsidian 675
onyx marble 1349
petroleum 938, 949, 962, 1074-1075
phosphate rock 273-274, 280-281
potash 90-92
analysis 90
pottery 547, 573, 580
pumice 271
salt 293-294, 303
sand and gravel 328-329, 331-332
sandstone 1290, 1329, 1332-1333, 1352
Page.
Utah, shales 86
slate 83, 1346
volcanic rocks 1347
Venetian red, imports 62
production 62, 65
Venezuela, asphalt 541-542
coal 783
magnesite 450
petroleum 1098
exports to 1063
Vermont, asbestos 339, 349
brick and tile 547, 558
clay 618
clay products 547, 558
feldspar 148, 151
furnace flux 1327
granite 1290, 1298, 1300, 1308-1310
lime 312, 317, 1530
limestone 1290, 1319, 1322-1323, 1530
marble 1290, 1314, 1317, 1530-1531
mineral waters 394, 398, 429
ocher 51
sand and gravel 328-329, 331-332
scythestones 259-260
slate 75-76, 83-84
soapstone 153, 163
talc 153, 155, 162
Victoria, coal 783
magnesite 450
Virginia, barytes 165-166, 171-172
brick and tile 547, 558
cement, Portland 121-122, 126
clay 618
clay products 547, 556, 610
coal 720, 726, 910-912
coke 461, 514
diamond 666
diatomaceous earth 180, 268
feldspar 148, 151
fuller's earth 109
furnace flux 1327
glass sand 328, 331
granite 1290, 1298, 1300
graphite 231-232
gypsum 356, 371-372
lime 312, 314, 317, 1533
limestone 1290, 1319, 1322-1323, 1532-1533
marble 1314, 1353
metallic paint 56
mica 2, 6-7
millstones 256-258
mineral waters 394, 398, 429
ocher 51
phosphate rock 285
pottery 547, 573, 581
pyrite 34, 40, 41
analysis of 41
salt 293-294, 303
sand and gravel 328-329, 331-332
sandstone 1290, 1329, 1333
slate 75-76, 84
soapstone 153, 163
talc 153, 155, 162
zinc oxide 59
Vitrified brick 549, 551, 558
Volcanic rocks (*see also* Stone industry) .. 1338-1405

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W. Page.
Washington, agate ... 654
brick and tile ... 547, 558
cement, Portland ... 121–122, 126
clay ... 618
clay products ... 547, 558, 611
coal ... 720, 726, 914–917
coke ... 461, 516
diatomaceous earth ... 180, 268
furnace flux ... 1327
granite ... 1290, 1298, 1300, 1399–1400
gypsum ... 356
lime ... 312, 314, 317
limestone ... 1290, 1319, 1322–1323, 1403–1405
marble ... 1314, 1402
metallic paint ... 56
mica ... 2
mineral waters ... 394, 398, 430
petroleum ... 962
pottery ... 547, 573, 581
sand and gravel ... 328–329, 331–332
sand-lime brick ... 18–19, 21
sandstone ... 1290, 1329, 1333, 1405–1407
trap rock ... 1290, 1312
volcanic rocks ... 1400–1402
West Australia, mica ... 2
West Indies, asphalt ... 543
coal, exports to ... 799
petroleum, exports to ... 1083–1084
West Virginia, asphalt ... 539
brick and tile ... 547, 558
bromine ... 307
calcium chloride ... 307
cement, Portland ... 121–122, 126
clay ... 618
clay products ... 547, 558, 612
coal ... 720, 726, 917–921
coke ... 461, 516
furnace flux ... 1327
gasoline from natural gas ... 1480–1481
glass sand ... 328, 331
grindstones ... 258
lime ... 312, 314, 317, 1533
limestone ... 1290, 1319, 1322–1323, 1532–1533
marble ... 1314, 1533
mineral waters ... 394, 398, 431
natural gas ... 1412–1420, 1426–1428
acreage ... 1421
petroleum ... 935, 938, 962, 973, 988–992
pottery ... 547, 573, 581
salt ... 293–294, 303–304
sand and gravel ... 328–329, 331–332
sand and sandstone ... 180
sandstone ... 1290, 1329, 1332–1333
Western Australia, coal ... 783
Western coal field, production ... 736
Whetstones, imports ... 260
production ... 259–260
White, granite, and semiporcelain ware ... 570, 573
White lead, imports ... 62
production ... 62–63

Page.
Whiting ... 58–59
Wisconsin, brick and tile ... 547, 558
clay ... 618
clay products ... 547, 558, 613
coke ... 461, 520
furnace flux ... 1327
glass sand ... 328
granite ... 1290, 1298, 1300, 1310–1311
graphite ... 188, 232
gypsum ... 356
leaded zinc oxide ... 61
lime ... 312, 314, 317, 1534
limestone ... 1290, 1319, 1322–1323, 1534
metallic paint ... 56
mineral waters ... 394, 398, 431
pottery ... 547, 573, 581
pyrite ... 34, 40
quartz ... 177–178
sand and gravel ... 328–329, 331–332
sand-lime brick ... 18–19, 22
sandstone ... 1290, 1329, 1332–1333
zinc oxide ... 59
World's production, asbestos ... 340
coal ... 781–784
graphite ... 189
gypsum ... 360
ocher ... 55
petroleum ... 941–943
phosphate rock ... 279
pyrite ... 36–37
umber ... 55
Wyoming, asbestos ... 349
brick and tile ... 547, 558
clay ... 618
clay products ... 547, 558
coal ... 720, 726, 922–925
graphite ... 233
gypsum ... 356, 372
lime ... 312, 317, 1550
limestone ... 1290, 1319, 1322–1323, 1550
marble ... 1550
mica ... 2
mineral waters ... 394, 398, 432
natural gas ... 1412–1420, 1455
acreage ... 1421
petroleum ... 935–939, 945, 948, 949, 962, 1075–1077
phosphate rock ... 273–274, 276–277, 280–281
sand and gravel ... 328–329, 331–332
sandstone ... 1290, 1329, 1333
sulphur ... 23, 27–28

Y.

Yale, Charles G., paper on borax ... 521–536
on magnesite ... 441–454
Yellow or Rockingham ware, value ... 570, 573

Z.

Zinc-lead, production ... 59, 61
Zinc oxide, imports ... 60
production ... 59–61

60326°—M R 1913—VOL 2——102

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